

RUDIMENTS
OF
NAVAL ARCHITECTURE;
OR,
AN EXPOSITION
OF THE
PRACTICAL PRINCIPLES OF THE SCIENCE
IN ITS
APPLICATION NC ...
TO ...
NAVAL CONSTRUCTION,
COMPILED FOR THE
USE OF BEGINNERS.

—
BY
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ASSISTANT MASTER SHIPWRIGHT, H. M. DOCKYARD, WOOLWICH, AND
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—

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TABLE OF CONTENTS.

PART I.

	Page
Introductory Remarks, and Description of the Principal Drawing of the Ship, and the Technical Terms for the Lines depicted on it	1

PART II.

Blocks on which the Ship is built.—How laid.—Description of the Frame, or the Skeleton of the Ship, as being composed of a vast assemblage of timbers.—The several Parts of the Frame described, as Keel, Stem, &c., and the Methods pointed out by which they are united	8
---	---

PART III.

Room and Space; being the Distance which the Frames are placed apart along the Keel, to form the Skeleton of the Ship	18
---	----

PART IV.

Description of the Deadwood, Apron, Stemson, Inner Post.—Cutting down of the Floors.—Raising of the Frames.—Securing of the Frames	20
--	----

PART V.

Description of the Fore Cant Timbers of the Frame.—Their Use.—Stem Pieces.—After Cant Timbers.—Changes in them in the Navy of this Country.—Keelson, or internal Keel.—Side-keelson	26
---	----

PART VI.

Fillings between the Frame of the Ship.—Introduction of them by Sir Robert Seppings.—Their intended Use.—The Methods first adopted, and those at present pursued in Her Majesty's Dockyards	32
---	----

PART VII.

Internal Trussing.—Introduction of it by Sir Robert Seppings.—Stability or Firmness of it.—Remarks on the Views taken of it by the Projector.—Former and latter Systems of Trussing the Ships of the Royal Navy contrasted	33
--	----

PART VIII.

Shelf or internal Hoop — May be considered as a Portion of the internal Planking worked to receive the Ends of the Beams.—Sections showing the relative Position of it with the Frame of the Ship.—Description of the Security used for it	Page 36
--	------------

PART IX.

Planking, or placing the Skin on the Skeleton or Frame.—Preliminary Remarks.—Description of the outside Plank, considered in the several Denominations of Wales or Bends, Diminishing Plank, Plank of the Bottom, and Garboard Strakes, with the Methods of converting and working them	38
---	----

PART X.

Inside Plank.—Description of the Limber Strakes.—Strakes over the Heads and Heels of the Frames of the Ship.—Beams.—Beams of the Ship considered as being connected with the Shelf and Waterway when the two latter are viewed as Portions of the internal Planking.—Remarks on Waterways, Clamps, Spirketting, and Trussing between the Ports	46
--	----

PART XI.

Description of the Action brought on the ends of the Beams of a Ship when rolling in a Sea.—Methods by which the ill effects of such racking or straining have been partially counteracted.—Breast-hooks and Crutches described, as formed of Iron, Wood and Iron, or wholly Wood.—Transoms, their Use	53
--	----

PART XII.

Framing the Decks or Platforms.—Mast Partners—as fitted in the British Navy—as fitted in the French Navy.—Framing to Hatchways and Ladderways.—Riding Bits, their Use and Position.—Admiral Elliot's Bits, where used.—Flat of the Deck.—Inner Waterways.—How secured in large Ships.—Ports.—Size, how determined.—Elevation and Depression of the Guns.—Distances between the Ports.—Limits to those Distances.—Description of the Port Lids, Half Ports, and Bucklars	57
---	----

CONTENTS.

PART XIII.

	Page
The Internal Space of the Ship.—How apportioned when fitted as a two-decked Ship of War, and appropriated to the usages of the British Navy, arranged under the several heads of Hold, Orlop, Lower or Gun Deck, Main or Upper Deck, Quarter Deck, Waist and Forecastle, Without Board, including a few cursory remarks on the fittings required for the sailing Evolutions of the Ship	62

PART XIV.

Measurement of a Ship or Vessel by the old Rule for Tonnage.—Rule given in detail.—Remarks on the Causes of the Rule being a faulty Approximation to the true Capacity of a Ship. — Rule practically applied to the Measurement of a Man-of-War.—Diagram showing the Method of applying the Rule	73
--	----

PART XV.

Measurement of a Ship or Vessel by the Rule for Tonnage enacted by Acts of Parliament of the Fifth and Sixth Years of the Reign of William IV.—Rule given in detail.—Rule applied practically.—The Measurement of a Vessel.—Diagram showing the Method of Application.—Necessary Deductions to be made when the Vessel measured by the Rule is to be propelled by Steam.—Short Description of a more satisfactory Method of obtaining the real Tonnage of a Ship .	79
--	----

PART XVI.

Mechanical Power used for Launching.—Declivity of the Slip and Blocks on which the Vessel is built.—Sliding Ways.—Bilgeways.—Spread of them.—Inclination of the Sliding Ways.—Whether laid straight or cambered.—Ribbands, their Use.—Method practised by the French in launching.—The Method described of putting the Bilgeways on the Sliding Ways.—Stopping-up Pieces.—Poppets.—Cleats on the Bottom.—Dagger Planks.—Paying Bilgeways and Sliding Ways with Tallow.—Setting up the Ship.—Removing the Building Blocks.—Christening the Ship.—Dog Shore.—Launch of the Ship	85
---	----

PART XVII.

Docks, how situated.—Entrance, how closed.—Gates or Caissoon.—Vessel's Position on the Blocks.—Guys or Ropes, their Use.—Shores, Breast; their Use.—Vessel, Upright or Plumb.—Method of determining it.—Diagonal Shores, their Position.—Bilge Shores.—	
---	--

	Page
Blocks, their Form.—Method of removing the Angular Blocks for False Keel.—Copper Sheathing, when removed.—Places usually defective, pointed out.—Defects should be rigidly searched for previously to the commencement of Repairs.—Advantages arising from such a course of procedure.—Inside and Outside Plank, when and where to be removed.—Beams and Iron Knees to be well examined.—Rudder to be unhung.—Pintle and Braces to be overhauled.—A Plate of a Dock with Reference to these Remarks subjoined	92

PART XVIII.

Principal Dimensions of the several rates of Ships in Her Majesty's Navy.—Armaments.—Weight of Anchors.—Weight of Cables.—Masts and Yards.—Weight of the Ship.—Weight of the Hull of the Ship.—Weight of the Material received on Board	99
---	----

PART XIX.

Scantlings or Dimensions of the principal Portions of her Majesty's Ships, usually termed "Scheme of Scantlings"	108
--	-----

PART XX.

Method of expanding (by means of the Sheer Drawing or Draught) the bottom of a Ship on Paper, or a Delineation of the whole Surface of the Outside of the Timbers that compose the Frame of her, a mechanical operation that enables the practical Ship Builder to arrange a disposition of the Plank and Thickstuff as a covering to the Timbers of the Ship under the Breadths, Lengths, and Positions that will be the most advantageous for Strength to the Ship and Economy in the conversion of the Store of Planking	120
---	-----

PART XXI.

Description of the Fittings to the Riding or Mooring Bits.—Common—Elliot's.—Description of, or References to Plate 5.—Deck Hooks, how formed.—Iron Crutches.—Iron Breast-Hook.—Cleats, their Form and Uses.—Method sometimes used to secure the Frames while being hoisted into position	127
--	-----

PART XXII.

Description of the several Modes used in Her Majesty's Service for uniting the Beams to the sides of the Ship.—References to Plate 8, or a descriptive Drawing of a Compressor for the Chain Cables	131
---	-----

PART XXIII.

	Page
Capstan, or the Mechanical Power employed to raise the Anchor.— Methods used for uniting the Cable and Capstan.—Fittings of the Capstan should never be slighted, and should be well tested.—Power Capstan attained by iron Machinery, not advisable for a Man-of-War.—Plate of a common Capstan, or one on which a Messenger is used.—Plate of Brown's patent Capstan, to which the Cable is brought without the intervention of a Messenger.—References to the Plates.—Windlass	135

PART XXIV.

Rudder ; its Action.—Efficient Angle to the Fore and Aft Line of the Ship.—Round-headed Rudders, when and where first introduced.—Advantages arising from the Use of them.—Subject to weakness from their Conversion.—References to Plate 9.—Description of the Rudder.—Wood-lock and Rudder.—Pendents, their Positions and Uses.—Temporary Rudders in Her Majesty's Navy	141
---	-----

PART XXV.

Remarks on the Application of Steam to the Propulsion of Ships ; first, when used as a Prime Mover ; secondly, when applied as an Auxiliary to the Sails.—Description of Plate 11, or references to the Elevation, Plan, and Section of a Paddle-box of a Steam Boat.—Modes of putting the Boat into the Water, and taking it out.—References to Plate 12, or a descriptive Sketch of the Aperture for the Screw Propeller.—Mode of raising the Propeller adverted to.—Danger that would arise from a Vessel propelled by the Screw touching the ground	143
---	-----

PART XXVI.

References to Sketch 13, descriptive of some of the Ordnance employed for Naval Purposes, and of the Fittings for their Use.—Weight of Powder in Shells.—Number of Shells for close Action.—Table of Powder supplied for each rate of Ship in Her Majesty's Navy	149
--	-----

PART XXVII.

Midship Section as linearly described in Plate 2.—References to the several Portions of it, as pointing out the relative Positions, by Sections, of the Timbers.—Planking, inside and out.—Beams and Decks.—Method employed if required to take off Ship when built.—	
---	--

References to Plate 4, as descriptive of the Methods which have been adopted in putting Beams together when they are composed of more than one piece.—References to a Sketch of the Deadwood of a large Frigate.—Method of making Floors in the rising Portion of the Ship's Frame.—Expansion of a common Frame of Timbers, and one composed of long and short armed Floors	^{Page} 154
---	------------------------

PART XXVIII.

Description of the Method employed to remove Slack Ropes in the Tiller of Her Majesty's Ship North Star.—References to the Elevation and Plan of the Sketch, describing the Method of reaving and fixing the Tiller Ropes.—Eye Bolts for relieving Tackles, where placed	161
--	-----

PART XXIX.

References to the Sketches of the Head and Stern of a Frigate.—Outline of the Terms used to distinguish the several Portions of them	164
--	-----

PART XXX.

A short Description of the Process used to make the Seams of the Plank of a Vessel impervious to Water.—Terms of some of the Tools used for that purpose.—Scale of the Width of Seams according to Thickness.—Seams of Decks sometimes payed with Jeffery's Marine Glue.—Copper Sheathing employed on the immersed Portions of the Ships of the Navy formerly payed with Pitch and Tar.—Weight of Copper Sheathing to each superficial Foot.—Concluding Remarks	169
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P R E F A C E.

IN placing before the British public a rudimentary work or outline of the Practice of Ship Building, ■ pursued in the Naval and Commercial Dockyards of this maritime country, but little préface or apology is required, the subject itself being of such importance to England as a nation, that an attempt, however feeble it may be, to diffuse such useful knowledge, will, the author feels convinced, be received with indulgence and good-will. The best bulwarks for England have ever been found to be her Wooden Walls, and theuce the alphabet, as it were, of the mechanical and practical carpentry of our national defences can never fail to excite an interest in all who bear the name of Englishman, ■ name carrying with it a feeling of proud and heart-felt estimation. That this small volume (completing the former volume of Elementary Principles) may be found useful to the youthful ship builders, who, in the course of events, must fill the stations of men who at the present period direct the Naval Architectural Department of this sea-girt island, and that it may prove instructive to the general reader, who may be under the conviction that a British Fleet must ever be the surest safeguard to his home, is the sincere wish of the author.

Woolwich,
May 31, 1851.

TABLE OF CONTENTS.

PART I.

	Page
Introductory Remarks, and Description of the Principal Drawing of the Ship, and the Technical Terms for the Lines depicted on it	1

PART II.

Blocks on which the Ship is built.—How laid.—Description of the Frame, or the Skeleton of the Ship, ■■ being composed of a vast assemblage of timbers.—The several Parts of the Frame described, ■■ Keel, Stem, &c., and the Methods pointed out by which they are united	8
---	---

PART III.

Room and Space; being the Distance which the Frames are placed apart along the Keel, to form the Skeleton of the Ship	18
---	----

PART IV.

Description of the Deadwood, Apron, Stemson, Inner Post.—Cutting down of the Floors.—Raising of the Frames.—Securing of the Frames	20
--	----

PART V.

Description of the Fore Cant Timbers of the Frame.—Their Use.—Stem Pieces.—Aster Cant Timbers.—Changes in them in the Navy of this Country.—Keelson, or internal Keel.—Side-keelson	■■
---	----

PART VI.

Fillings between the Frame of the Ship.—Introduction of them by Sir Robert Seppings.—Their intended Use.—The Methods first adopted, and those at present pursued in Her Majesty's Dockyards	■■
---	----

PART VII.

Internal Trussing.—Introduction of it by Sir Robert Seppings.—Stability or Firmness of it.—Remarks on the Views taken of it by the Projector.—Former and latter Systems of Trussing the Ships of the Royal Navy contrasted	33
--	----

PART VIII.

Shelf or internal Hoop — May be considered ■ a Portion of the internal Planking worked to receive the Ends of the Beams.—Sections showing the relative Position of it with the Frame of the Ship.—Description of the Security used for it	Page 36
---	------------

PART IX.

Planking, or placing the Skin on the Skeleton ■ Frame.—Preliminary Remarks.—Description of the outside Plank, considered in the several Denominations of Wales or Bends, Diminishing Plank, Plank of the Bottom, and Garboard Strakes, with the Methods of converting and working them	38
--	----

PART X.

Inside Plank.—Description of the Limber Strakes.—Strakes over the Heads and Heels of the Frames of the Ship.—Beams.—Beams of the Ship considered as being connected with the Shelf and Waterway when the two latter are viewed as Portions of the internal Planking.—Remarks on Waterways, Clamps, Spirketting, and Trussing between the Ports	46
--	----

PART XI.

Description of the Action brought on the ends of the Beams of a Ship when rolling in ■ Sea.—Methods by which the ill effects of such racking ■ straining have been partially counteracted.—Breast-hooks and Crutches described, as formed of Iron, Wood and Iron, or wholly Wood.—Transoms, their Use	53
---	----

PART XII.

Framing the Decks or Platforms.—Mast Partners—as fitted in the British Navy—as fitted in the French Navy.—Framing to Hatchways and Ladderways.—Riding Bits, their Use and Position.—Admiral Elliot's Bits, where used.—Flat of the Deck.—Inner Waterways.—How secured in large Ships.—Ports.—Size, how determined.—Elevation and Depression of the Guna.—Distances between the Ports.—Limits to those Distances.—Description of the Port Lids, Half Ports, and Bucklars	57
---	----

CONTENTS.

PART XIII.

	Page
The Internal Space of the Ship.—How apportioned when fitted ■ ■ two-decked Ship of War, and appropriated to the usages of the British Navy, arranged under the several heads of Hold, Orlop, Lower or Gun Deck, Main or Upper Deck, Quarter Deck, Waist and Forecastle, Without Board, including ■ few cursory remarks on the Fit-tings required for the sailing Evolutions of the Ship	62

PART XIV.

Measurement of ■ Ship or Vessel by the old Rule for Tonnage.—Rule given in detail.—Remarks on the Causes of the Rule being a faulty Approximation to the true Capacity of ■ Ship. — Rule practically applied to the Measurement of a Man-of-War.—Diagram showing the Method of applying the Rule	73
--	----

PART XV.

Measurement of ■ Ship or Vessel by the Rule for Tonnage enacted by Acts of Parliament of the Fifth and Sixth Years of the Reign of William IV.—Rule given in detail.—Rule applied practically.—The Measurement of a Vessel.—Diagram showing the Method of Application.—Necessary Deductions to be made when the Vessel measured by the Rule is to be propelled by Steam.—Short Description of a ■ satisfactory Method of obtaining the real Tonnage of a Ship .	79
---	----

PART XVI.

Mechanical Power used for Launching.—Declivity of the Slip and Blocks on which the Vessel is built.—Sliding Ways.—Bilgeways.—Spread of them.—Inclination of the Sliding Ways.—Whether laid straight or cambered.—Ribbands, their Use.—Method practised by the French in launching.—The Method described of putting the Bilgeways on the Sliding Ways.—Stopping-up Pieces.—Poppets.—Cleats on the Bottom.—Dagger Planks.—Paying Bilgeways and Sliding Ways with Tallow.—Setting up the Ship.—Removing the Building Blocks.—Christening the Ship.—Dog Shore.—Launch of the Ship	85
---	----

PART XVII.

Docks, how situated.—Entrance, how closed.—Gates or Caissoon.—Vessel's Position on the Blocks.—Guys or Ropes, their Use.—Shores, Breast; their Use.—Vessel, Upright or Plumb.—Method of determining it.—Diagonal Shores, their Position.—Bilge Shores.—	■
---	---

CONTENTS.

Blocks, their Form.—Method of removing the Angular Blocks for False Keel.—Copper Sheathing, when removed.—Places usually defective, pointed out.—Defects should be rigidly searched for previously to the commencement of Repairs.—Advantages arising from such a course of procedure.—Inside and Outside Plank, when and where to be removed.—Beams and Iron Knees to be well examined.—Rudder to be unbung.—Pintle and Braces to be overhauled.—A Plate of a Dock with Reference to these Remarks subjoined	Page 92
---	------------

PART XVIII.

Principal Dimensions of the several rates of Ships in Her Majesty's Navy.—Armaments.—Weight of Anchors.—Weight of Cables.—Masts and Yards.—Weight of the Ship.—Weight of the Hull of the Ship.—Weight of the Material received on Board	99
---	----

PART XIX.

Scantlings or Dimensions of the principal Portions of her Majesty's Ships, usually termed "Schematic of Scantlings"	108
---	-----

PART XX.

Method of expanding (by means of the Sheer Drawing or Draught) the bottom of a Ship on Paper, or a Delineation of the whole Surface of the Outside of the Timbers that compose the Frame of her, a mechanical operation that enables the practical Ship Builder to arrange a disposition of the Plank and Thickstuff as a covering to the Timbers of the Ship under the Breadths, Lengths, and Positions that will be the most advantageous for Strength to the Ship and Economy in the conversion of the Store of Planking	120
---	-----

PART XXI.

Description of the Fittings to the Riding or Mooring Bitts.—Common—Elliot's.—Description of, or References to Plate 5.—Deck Hooks, how formed.—Iron Crutches.—Iron Breast-Hook.—Cleats, their Form and Uses.—Method sometimes used to support the Frames while being hoisted into position	127
--	-----

PART XXII.

Description of the several Modes used in Her Majesty's Service for uniting the Beams to the sides of the Ship.—References to Plate 8, or a descriptive Drawing of a Compressor for the Chain Cables . . .	131
---	-----

PART XXIII.

	Page
Capstan, — the Mechanical Power employed to raise the Anchor.— Methods used for uniting the Cable and Capstan.—Fittings of the Capstan should never be slighted, and should be well tested.—Power Capstan attained by iron Machinery, not advisable for a Man-of-War. —Plate of a common Capstan, or one — which a Messenger is used. —Plate of Brown's patent Capstan, to which the Cable is brought without the intervention of a Messenger.—References to the Plates.— Windlass	135

PART XXIV.

Rudder ; its Action.—Efficient Angle to the Fore and Aft Line of the Ship.—Round-headed Rudders, when and where first introduced.— Advantages arising from the Use of them.—Subject to weakness from their Conversion.—References to Plate 9.—Description of the Rudder. —Wood-lock and Rudder.—Pendents, their Positions and Uses.— Temporary Rudders in Her Majesty's Navy	141
---	-----

PART XXV.

Remarks on the Application of Steam to the Propulsion of Ships ; first, when used as a Prime Mover ; secondly, when applied as an Auxiliary to the Sails.—Description of Plate 11, or references to the Elevation, Plan, and Section of a Paddle-box of a Steam Boat.— Modes of putting the Boat into the Water, and taking it out.— References to Plate 12, or a descriptive Sketch of the Aperture for the Screw Propeller.—Mode of raising the Propeller adverted to.— Danger that would arise from a Vessel propelled by the Screw touching the ground	143
--	-----

PART XXVI.

References to Sketch 13, descriptive of some of the Ordnance employed for Naval Purposes, and of the Fittings for their Use.—Weight of Powder in Shells.—Number of Shells for close Action.—Table of Powder supplied for each rate of Ship in Her Majesty's Navy	149
---	-----

PART XXVII.

Midship Section — linearly described in Plate 2.—References to the several Portions of it, as pointing out the relative Positions, by Sec- tions, of the Timbers.—Planking, inside and out.—Beams and Decks. —Method employed if required to take off Ship when built.—	
--	--

References to Plate 4, — descriptive of the Methods which have been adopted in putting Beams together when they are composed of more than ■ piece.— References to a Sketch of the Deadwood of a large Frigate.— Method of making Floors in the rising Portion of the Ship's Frame.— Expansion of a ■ Frame of Timbers, and one composed of long and short armed Floors	^{Page} 154
--	------------------------

PART XXVIII.

Description of the Method employed to ■ Slack Ropes in the Tiller of Her Majesty's Ship North Star.— References to the Elevation and Plan of the Sketch, describing the Method of reaving and fixing the Tiller Ropes.— Eye Bolts for relieving Tackles, where placed . . .	161
---	-----

PART XXIX.

References to the Sketches of the Head and Stern of a Frigate.— Outline of the Terms used to distinguish the several Portions of them . . .	164
---	-----

PART XXX.

A short Description of the Process used to make the Seams of the Plank of a Vessel impervious to Water.— Terms of some of the Tools used for that purpose.— Scale of the Width of Seams according to Thickness.— Seams of Decks sometimes payed with Jeffery's Marine Glue.— Copper Sheathing employed on the immersed Portions of the Ships of the Navy formerly payed with Pitch and Tar.— Weight of Copper Sheathing to each superficial Foot.— Concluding Remarks . . .	169
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RUDIMENTARY TREATISE

SHIP BUILDING.

PART I.

Introductory Remarks and Description of the Principal Drawing of the Ship, and the Technical Terms for the Lines depicted on it.

IT is to be doubted to whom the most credit pertains—to the savage who hollowed out the trunk of a tree to enable him to ensnare the finny tribe, or to the skilled artisan that has raised, piece by piece, the vast fabric which at length presents to the wondering gaze of the uninitiated that most complicated of all machines, a first-rate man-of-war; destined to carry weal or woe to all quarters of the globe. The formation of the canoe, would be to those who are cunning craftsmen in the trade, a puny effort of the school-boy with his knife to form the model boat to carry the paper sail; and a description of the process by which the bark of the juvenile was formed to cleave the miniature waves of the mill-pond, would be, by such adepts in their art, received with smiles or contempt. The object of the present rudimentary treatise is to lead the boy from the architecture of the pond to that of the ocean; to place in his hands, in a simple and perspicuous style, the transition from the use of the knife in forming the boat, to the results arising from the skilful use of tools in shaping vast loads of rough logs or trees into the ship for War or Com-

merce. It should first be premised, that the ship does not swim because she is built of wood. Some woods are heavier than water, and sink when immersed in that fluid, the same as would iron. That the materials of which these floating locomotive machines may be constructed is irrespective of the property of most woods—that of swimming in water, may be inferred from the wonders of the present day, when ships may be found formed of iron that swim as buoyantly as those composed of wood, *nay, more so*; and they not only swim, but they have traversed the trackless road of the ocean, and have sailed round the world. That the materials to form a floating body are not of necessity required to be lighter than the water it is to float in, may be exemplified by the satisfactory and easily-practised experiment of making one cup of a tea-set swim within the other. In what then consists this property, as it were, of keeping its head above water? It is that of giving to the part of the body which is intended to go under water, a bulk or size that will make a cavity in the fluid, when the body is placed in it, that would contain a mass of the water equal in weight to the weight of the immersed and emerged portions of the structure. Thus, in the case of the two tea-cups, the thin lamina of clay that forms the floating cup—the outside that is immersed and the inside that is preserved from immersion by that lamina—would sink if formed into a solid square mass: the extended surface given to it makes a small immersion of it in the fluid, displace or put out of its place a body of the fluid equal in weight to the weight of the clay; and thus one cup rides as triumphantly within the other as the first-rate man-of-war does on the ocean of the world.

The draught of a ship is the delineation of the various sections of her by lines; the lines being the outer edges of such sections. To elucidate what is here meant: if an orange is cut into two parts, the edge of the peel in each of those parts will be a round or circle, and thus denote the shape of it. And if those parts be again subdivided, their outer

edges will have a similar form,—and the orange, by such a development, would be found to assimilate in form to a sphere or globe. The naval architect or constructor determines the relation which the principal dimensions of the ship, or those of the length, breadth, and depth of her should bear to each other, the form best adapted for the required service, and its capabilities; the practical ship-builder having the same relation to the naval architect that the house-builder has to the civil architect. Each of the architects is a designer in his respective science, whose designs, when completed on paper, require the able assistance of the practical man, that the one may become the graceful and symmetrical figure portrayed by a man-of-war, or the other stand forth as the stately palace of a sovereign.

The Construction-Drawing, from the sections of it being made to the outside of the exterior planking for calculation, as it comes from the hands of the naval architect, would not be available for the purposes of the practical builder, whose delineation on paper, or draught of the ship, and its consequent full development on the mould-loft floor requires to be to the outside of the timbers or inside of the exterior plank; the fact being, that the moulds, for convenience, are made to the form of the timbers only, and the timbers are trimmed by them, then put together, raised, and placed in position to receive the plank. The frame-timbers may be considered as forming ribs, to give the form of the ship, to which the planking has to be added, to give buoyancy and substance to the mass. The method of preparing the building draught of the ship from that which is furnished by the naval architect or the construction-drawing, will not be described in this work, as the process necessary to do it is more within the province of the mould-loft, and will be included in the treatise descriptive of the work done in that place.

The principal drawing of a ship, denoted the Sheer Drawing, is composed of three parts, mutually dependent on each other. They are each sectional planes considered as passing through

the largest portions of the principal dimensions of her. They are severally named—the Sheer Plan, Half-breadth Plan, and Body Plan.

The Sheer Plan is descriptive of the longest and deepest longitudinal section in the ship, or that of a plane passing through the middle line of the vessel from the middle line of the stem or fore-boundary of her, to the middle line of the stern-post or after-boundary (Fig. 1. p. 11). On this plane the position of any point in the ship may be determined for height and length, as being projected on to that plane, similar to the process followed in the delineation of a map.

The Half-breadth Plan is descriptive of half of the widest and longest level section in the ship, or that of a horizontal plane passing through the length of the ship at the height of the greatest breadth (Fig. 1). On this plane the position of any point in the vessel may be fixed by projection, as to width and length.

The Body Plan is descriptive of the largest vertical and athwartship section of the ship; forming the boundary of all the others, which are delineated within it (Fig. 1); and this plan fixes by projection the height and width of any point in the vessel.

There are thence three plans used to describe the ship, considered as solid, or as being made up of three dimensions, length, breadth, and depth; and these are dependent on each other, as the—

Sheer plan gives the height and length.

Half-breadth gives the breadth and length.

In which the length is common to the two.

Sheer plan gives the length and height.

Body plan gives the breadth and height.

In which the height is common to the two.

Half-breadth gives the length and breadth.

Body plan gives the height and breadth.

In which the breadth is common to both.

To determine the true position of each point of any solid

ON SHIP BUILDING.

three linear measurements ■ required—the height, the breadth, and the length of it, all of which must be set off from, or bear reference to, ■ standard plane or starting point. The plans described for the ship fully furnish these dimensions for each point in her, as they may be considered the sides, top, and ends of ■ block formed to the dimensions of the ship, and each point in her has double reference to the several plans, ■ the sheer, half-breadth, and body plans.

Thus the point in the half-breadth plan, or top of the block, if projected downwards, will meet the ■ representative point, shown on the sheer plan, projected inwards ■ athwartship: these must coincide, for they represent the same point in space, which means the same identity. This reasoning will extend itself to the rest of the linear delineation of the draught of a ship; on which, by these means, the intended form is fully described, and the internal arrangements depicted upon scale, and the practical builder has thence the whole fabric under his eye at one glance. The lines shown on the practical drawing in blue ink are called water-lines (Fig. 1, marked *a a*), forming, in the half-breadth plan, the boundaries of the several sectional areas; the upper one being the intended line of floatation, and the others being drawn parallel to it. In the sheer plan, from being the projection of these lines, their position and form is indicated by straight lines; and the height from the keel, and the relative distance from the bow or stern of any point of them, may be determined on it, but not the breadth of that point from the middle line of the ship. In fact, the sheer plan is but ■ surface or plane, made up of length and breadth, and cannot thence be descriptive of more than those two dimensions of the solid.

In the half-breadth plan (Fig. 1), the water-lines are descriptive of the form of the ship, ■ being made up of ■ succession of breadths of her, at the heights pointed out by the corresponding heights of the water-lines in the sheer plan.

the points denoting such breadths being in each plan at the same lengths from the bow or stern.

In the body plan (Fig. 1), the water-lines are in the form of a curve, arising from the difference of draught of water given to the ship, which causes the several points of the plane to be shown above each other in succession, beginning from forward. These heights correspond with the heights descriptive of the same points in the sheer plan, and the breadths of the vertical sections of the body plan at these assumed positions are co-equal with those of the same points in the half-breadth plan; and the young draughtsman should bear well in mind that the lines denoting the upper edge of the rabbet of the keel, middle line of the ship, both vertically and longitudinally, or the common sections of the longitudinal and vertical sections of the ship, form the bases from which the dimensions of the ship are set off, and from which, as a standard, all the other parts are measured.

A diagonal line (Fig. 1, c) is a curve line which bounds a section or area of the body in an oblique direction; they are drawn in red in the body plan of the draught, where they are usually made to denote the heads and heels of the timbers, and by projection they are in that plan represented by a straight line. These lines are considered the most effectual towards fairing the body of the ship, or making the one portion of her assimilate with the other. The diagonals run off from the body plan, for the form of the diagonal section to be shown on the half-breadth plan, c, where it will be developed as a curve, by taking the diagonal distances along them from the middle line of the body plan to where the representative diagonal of the body plan cuts the curves which represent the respective timbers or boundaries of the vertical sections of the body; the diagonal distances thus taken being severally set off from the middle line of the half-breadth plan as the lines or stations which represent as it the positions of the corresponding vertical sections of the body plan;

such vertical sections of the body being by projection delineated by straight lines in both sheer and half-breadth plans, — shown in Fig. 1.

A curve passed through the spots thus obtained will be the boundary of a plane cutting the frame of the ship obliquely; or of a plane that, if it were hung with hinges at the middle line of the vessel, would, when allowed to fall to the given angle from the horizon, be found to coincide with the proposed form of the body of the ship: these curves give the shape of the harpins and ribbands of the practical building, which will be further adverted to in the treatise — Laying off Ships on the Mould-Loft Floor.

Buttock and bow lines (Fig. 1, marked *b*) are the boundaries of planes which are supposed to pass fore and aft through the whole length of the ship, and parallel to the middle plane of her; these lines by projection — indicated by straight lines in the body and half-breadth plans, but in the sheer plan they are curves bounding the sectional areas, and denoting by their form and regularity the symmetry of the vessel as well as the fairness of her. The buttock lines — those portions of these lines which lay towards the after-part of the ship; the bow lines those which are at the bow or fore-portion of her. The method of setting off these lines on the sheer plan is by taking off the heights in the body plan, where the straight line drawn to represent the buttock or bow line cuts the several curve lines denoting the vertical sections in it, and transferring these heights to the corresponding stations in the sheer plan, setting them up from the line which has been fixed upon to denote the upper edge of the rabbet of keel in that plan; — a curve passed through the points thus obtained will be the bow or buttock line, — the case may be. The ending or termination of these lines has not been pointed out; it being more in the province of the mould-loft, and will be described in a subsequent rudimentary work, on laying off ships.

of a ship, a few words may not perhaps be misplaced, when a regret is expressed, that the profession of the naval architect and the trade of the ship-builder have been in this country at such a low ebb for many years past. Little encouragement has been given (nay, persecution has been shown) to men who had devoted their time and talents to ■ steady course of inductive principles to be applied to the improvement of the ships of the British navy; while imaginative and amateur constructors have basked in the full blaze of official patronage, and the treasures of England have been expended in building ships of a faulty construction or form, that may in the days of future strife tend, from their bad qualities, in no small degree to compromise the honour of the British seaman.

PART II.

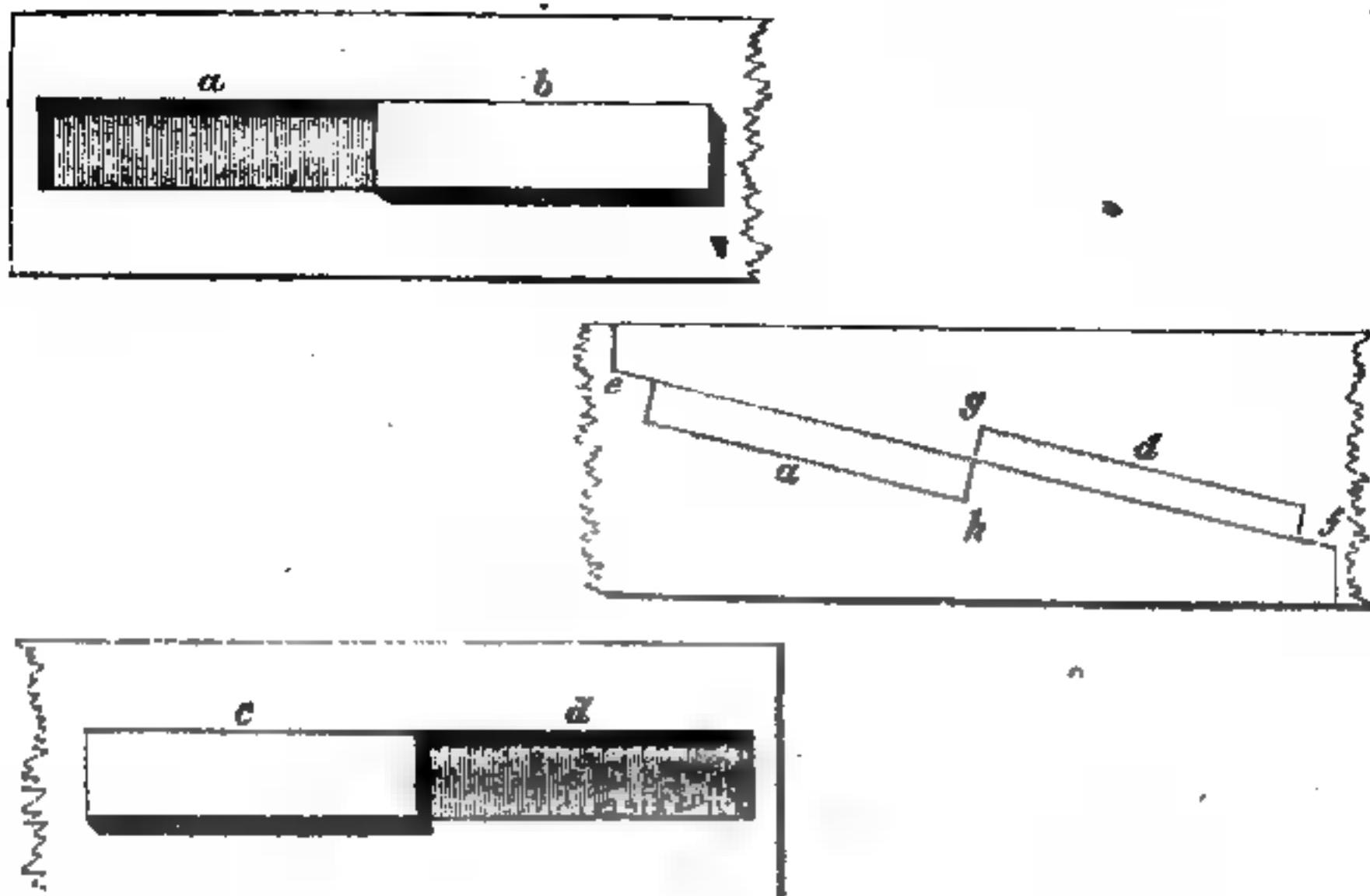
Blocks on which the Ship is built—bow laid.—Description of the Frame or the Skeleton of the Ship, as being composed of a vast assemblage of timbers.—The several Parts of the Frame described, and the Methods pointed out by which they are united.

THE blocks on which the keel of the ship is laid after it is trimmed or fashioned by tools, are piles of short and thick pieces of timber, placed one above the other to a height determined by the declivity of the slip on which they are placed. The lower piece of each tier is the largest, and is termed the groundway. The upper one is called the cap of the block, and should be of free wood, easily to be split out for launching. When the vessel is built on angular blocks, the cap block for splitting out is not required, and in such instances the cap, the depth of the false keel ■ keels, is the one that is obtained of free-grained wood, for easy removal. Above this cap, ■ thickness of block, equal to the depth of the false keel or keels, is worked. The blocks have their upper sur-

faces to the inclination of $\frac{5}{8}$ of ■ inch to ■ foot, and the ship, while building, is inclined to the horizon at the angle given by such a depression. The after blocks, if above 5 feet in height, are braced together, and shored on their after-sides.

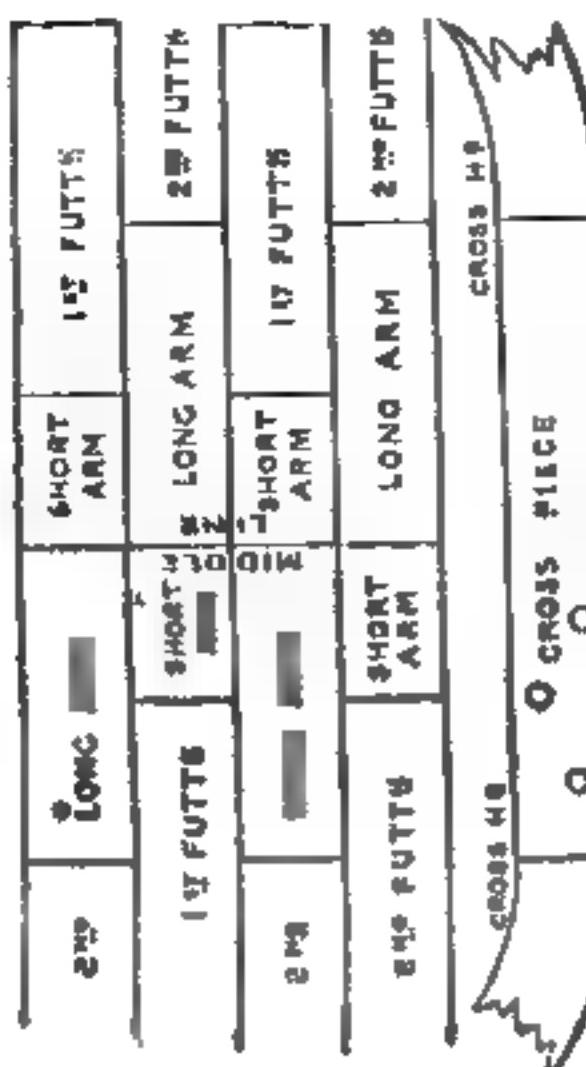
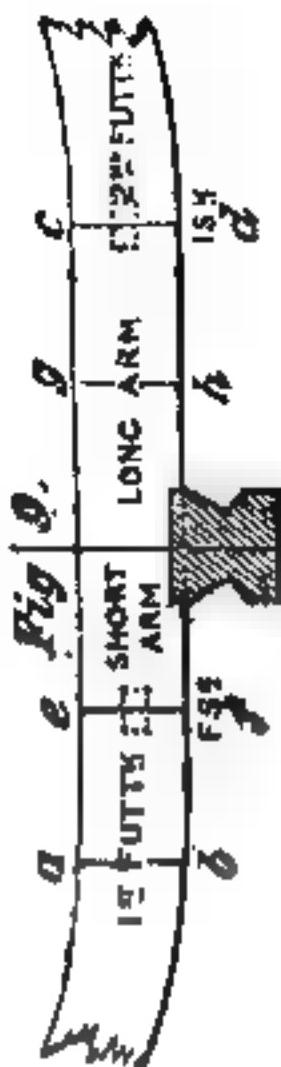
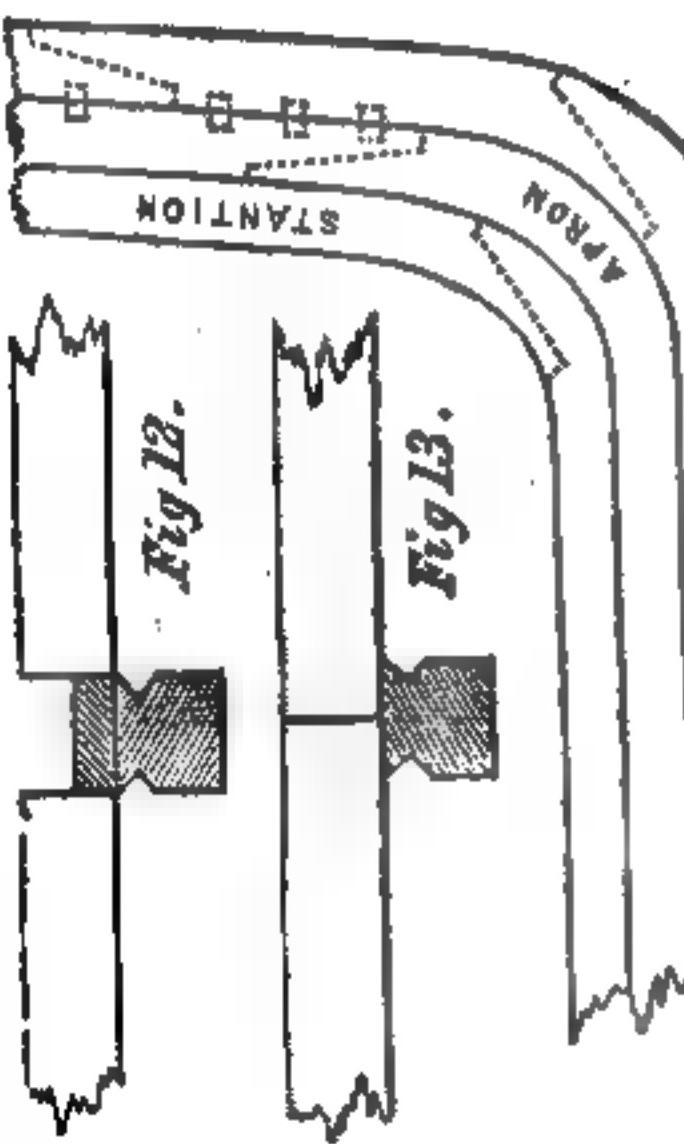
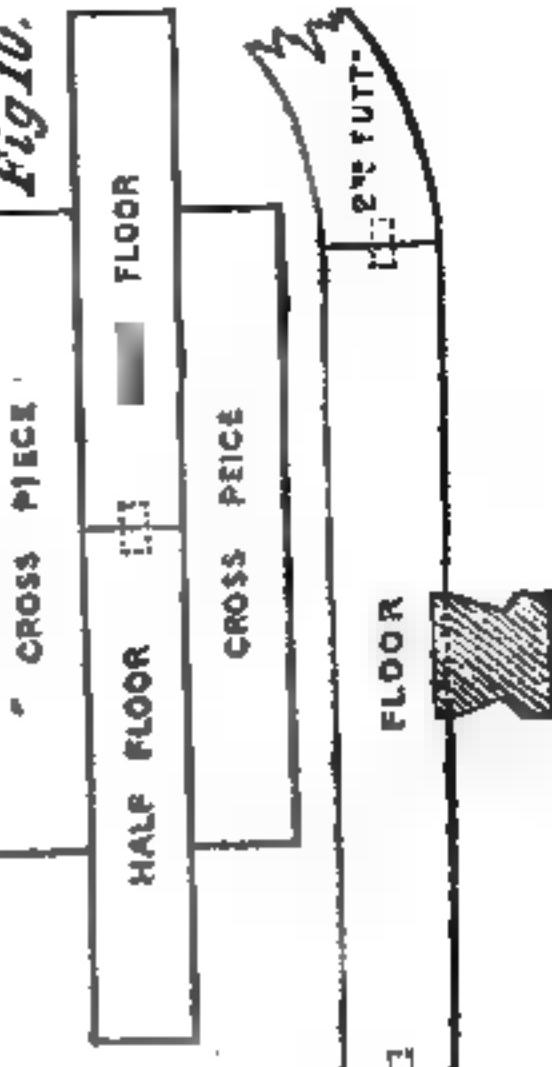
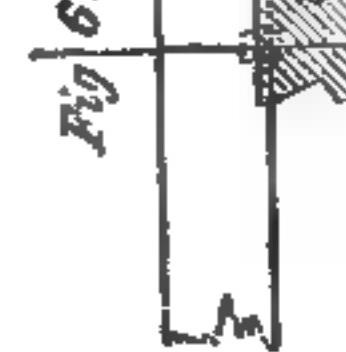
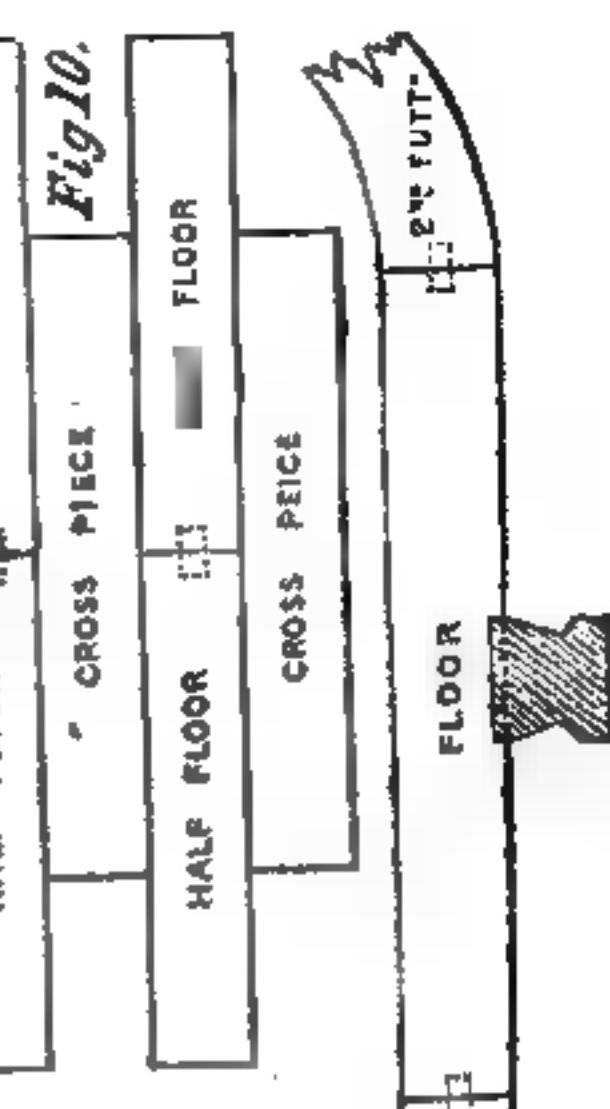
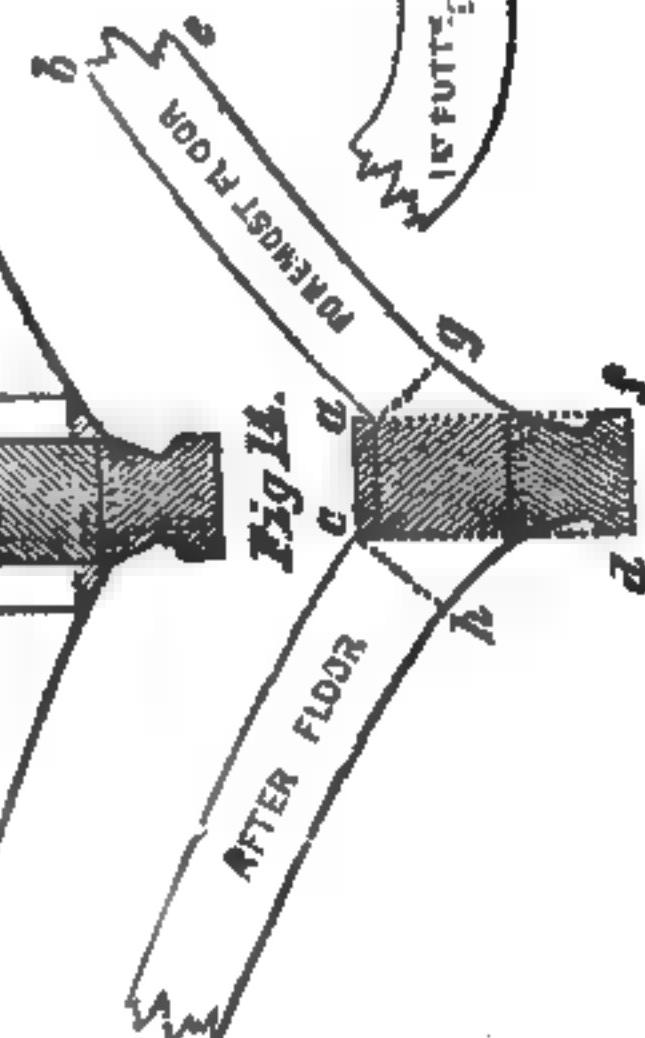
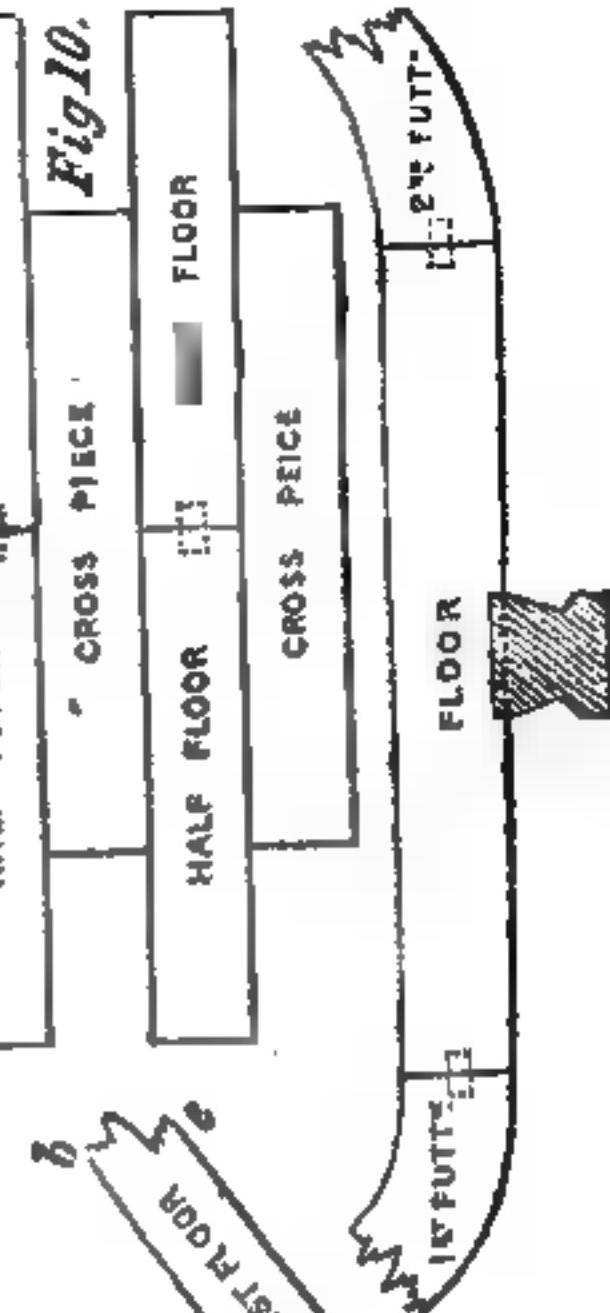
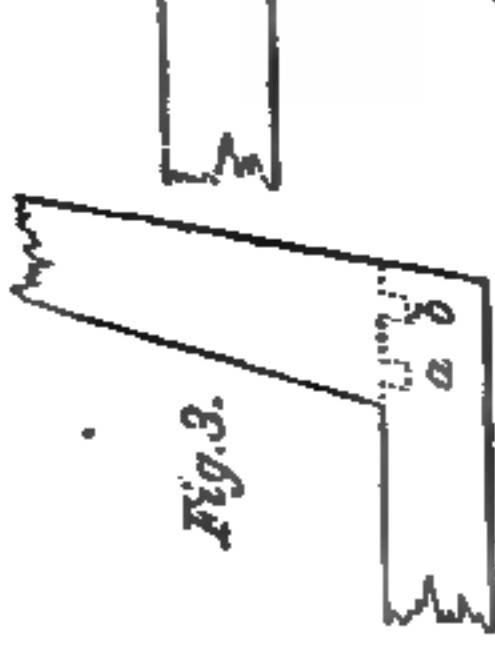
It has not unaptly been suggested that the keel may be denominated the back-bone of the ship, and that the timbers of her frame bear the same analogy to the structure that the ribs do to the human frame. The planking of the ship, under such ■ comparison, may with equal force be looked upon as the skin to the structure making up the fabric. The keel is usually composed of elm, a wood that is preserved by being immersed in water. The fibres of this wood are tough, and well adapted to receive the numerous fastenings or bolts that pass through it, such as the bolts through the lower timbers of the frames called floors. The size of the keel in ■ first-rate man-of-war is 20 inches by 20 inches, technically styled 20-inches square. The number of pieces of which it is composed in length, depends on two conditions—the length required by the draught or drawing of the ship, and the store of timber which the builder has at his command. The last condition should be kept in view by the practical shipwright throughout the whole of the mechanical operations of the shipwright carpentry. He should never lose sight of the old and trite proverb of "cutting his coat according to his cloth." These pieces of keel, in ■ first-rate, rise in number to eleven or twelve or thirteen pieces; and it has been usual to have the after-one of oak. The fore-mast piece, in the Queen's service, has the fore-end curved up to form what is called the boxing or the over-lap of the keel with the stem to unite them together, which mode of connecting one piece of timber with another is usually termed ■ scarph. The scarphs of the keels ■ locked into each other by raised and sunken portions of them, ■ shown by the sketch in next page.

■ b the overlap or length of the scarph of the one piece of keel; ■ d the overlap of the other; ■ a sunken groove, in



dimensions $\frac{1}{3}$ rd the width of the piece, and one-half of the length of the scarph, the depth being $1\frac{1}{2}$ inch; *b* the wood left above the plain surface *e f*, equal in size to the hollow *a*; the surface of the scarph of the other piece has the raised wood at *c*, and corresponding sunken groove at *d*: when these two surfaces are brought together, the groove *a* receives the raised wood *c*, and the groove *d* receives the raised wood *b*, thus locking the two pieces of keel together, the abutment *g h* of 3 inches resisting any strain brought on the pieces of keel to pull them apart. This method of uniting is technically termed a tabled scarph; the length of the scarph is determined by the distance between the timbers of the ship, the scarph being long enough to take two of the bolts through the keelson—a timber that will be shortly described.

The rabbet or groove sunk in it to receive the plank of the bottom is usually, in the merchant service, taken out at the upper side of the keel, ■ shown in the sketch (Fig. 1, p. 11), and marked *a b c*, leaving the depth *c d* below the plank. In the Queen's service the rabbet is brought to the lower part of ■ keel *f*, the lower part of the groove or rabbet being only 4 inches from *e*, or *f e* is equal to 4 inches; the rabbet ■ the

*Fig. 3.**Fig. 8.**Fig. 10.*

lower side, or fg , is taken out in the same way ■ $c b$ of the old system ; but the depth of it, $f h$, is increased, ■ that h may be within $1\frac{1}{2}$ or 2 inches of the upper side of the keel, ■ ih ; and the rabbet is then formed to the figure of which $h g f$ is ■ section. This formation of the rabbet of the keel admits of ■ thick plank being worked next to the keel ; and, indeed, the system thus described, of working the keel and planks of the bottom immediately in junction with the keel (technically called garboard strakes) may be said to form ■ combination of keel-pieces ; and where strength and efficiency are more considered than expense, the safety keels of Mr. Lang, master shipwright of Woolwich Yard, will be adopted by merchant builders. In the Queen's service, the good results or safety of the ships that have ■ numerous instances attended on the plan has caused the system to be universally adopted. The strength which is given to the fabric by this combination of keel-pieces is not the only advantage which the system presents. In the old plan, the depth of the keel below the rabbet cd forms a lever, on the vessel taking the ground, to assist in tearing the keel out of its place. In the new plan the distance (fe) is not more than $\frac{1}{4}$ th the distance (cd), which diminishes the lever $\frac{3}{4}$ ths of its length ; and, in addition, the thick garboard or keel-pieces form firmer resistance or abutments to any movement in the keel longitudinally.

FALSE KEELS.

Below the main keel, pieces of elm from 4 to 6 inches in thickness are worked of the ■ breadth as the keel, the whole extent of it ; the butts or ends of these pieces of wood should be placed between the scarphs of the main keel : the object of this addition to the depth of the vessel is to give her a greater immersion to prevent lee-way, and that, in the event of the ship taking the ground when in shoal ■ shallow water, the false keel, being only slightly secured to the main keel, may be easily forced off from it and the vessel be freed from her danger.

STEM,

The foremost boundary of the ship, being a continuation of the keel to the height of the vessel at the fore extreme of her: it is usually composed of English oak timber, and receives in ■ groove taken out of it, technically termed ■ rabbet, the whole of the fore-ends of the plank of the bottom, called fore-hoods. In large vessels the stem is, from the difficulty of finding timber of sufficient dimensions, composed of three pieces, distinguished as being the upper, middle, and lower pieces of stem; these are united to each other and to the fore-end of the keel by scarphs, as described for the keel, or with coaks; the scarph which unites it with the keel being in mechanical terms denominated the boxing. (Sketch of the boxing, Fig. 8, p. 11). The stem is wider in the sided way or thickness at the head or upper part of the upper piece, the lower end of the lower piece being of the ■ thickness or siding ■ the keel at their junction. The most desirable position for these scarphs of the stem will be pointed out when the description of the construction of the frame of a vessel is farther advanced; the security of them, ■ restricted to the stem itself, consists of round pieces of dry wood, called coaks, and copper bolts, usually placed ■ described by the annexed sketch, at Fig. 2, p. 11, where the coaks are marked thus, O, and bolts o.

STERN-POST,

The after-boundary of the frame, ■ ribs of the ship, being the after continuation of the keel to the height of the deck, and forming, similarly to the ■ of the stem and planking forward, the receptacle for the after-ends of the plank of the bottom, a groove being taken out of it called ■ rabbet, to receive these ends, which in mechanical phraseology ■ termed after-hoods. The stern-post is usually of English oak, when the dimensions of it and store of timber will admit, of

such a conversion, and is usually in one piece; it should be of sound quality and well seasoned. Sometimes in large vessels a false post is worked at the after-part of the main-post, to reduce the required dimensions of this portion of the frame; such conversion or provision should be avoided, if possible, the post being the foundation to which the rudder is hung, and thence requiring solidity of construction. Should it be impossible to obtain the main-post of a large ship in one, the expedient that has been sanctioned is to have the lower end scarphed, placing the outer butt of the scarph under one of the braces worked on the post, for the reception of the rudder, or for forming the hinges on which the rudder hangs. (See Rudder). The lower end of the stern-post, technically termed the heel of it, is inserted into the after-piece of keel, to which it corresponds in thickness or siding, by tenons or teeth, which fit into mortices or grooves sunk in the upper and after part of the keel to receive it.

a b tenons or teeth in the post, or mortices in the keel (Fig. 3, p. 11).

Occasionally, to assist the conversion of the timber for the post, the after length of keel, or after-piece of keel, is worked up as shown in the sketch (Fig. 4, p. 11), which is, in fact, making the after extreme similar to the fore, and decreasing the expense of the stern-post by an increase in expenditure in the conversion of the keel. The store of timber will best determine which expedient should be adopted.

There is also an inner post, which is made to succour the main-post by being brought on the fore side of it: it is dowelled to the main-post, and may be fairly considered on making up a combination of timber that would be provided in one if the trees were of sufficient size. In round and elliptical sterns, timbers called post-timbers are worked on each side of this part of timber to form the shape of the vessel at the extreme after-part, giving to it the rake and contour of the stern.

The frame of the ship, or what is sometimes termed the ribs, which, ■ before stated, may not unaptly be compared to that part of the human frame that bears the same title, is the portion of the structure that gives the form or shape of the vessel. It is composed of numerous assemblages of timber, denominated either floors, cross-pieces, half-floors, floors short and long armed, 1st futtocks, 2nd futtocks, 3rd futtocks, 4th futtocks, 5th futtocks, top timbers, according to the carpentry that is to be used in putting the vessel together; and here the skill and ability of the practical naval architect will be evinced, as the maximum of strength and minimum of expense in the frame, under the form given to the ship, will be alone obtained by the judgment shown by the converter or cutter out in giving the best arrangement of length to the several portions of the frame or to the shift of timbers. In this stage of the work, the store of timber should be well considered and carefully examined, and probable difficulties in following up his intentions and the expense attending it, should check the views of the designer of the combination, towards completing what would seem to be the ultimatum of his wish; for maximum or greatest strength should be well weighed with the practical certainty of its accomplishment, under the resources at his command, ■ in most instances ■ trifling deviation from the design will be attended with very salutary effects on the ease of conversion and the price of the frame of the ship.

FLOORS.

In the merchant service at the present day, and formerly in the British navy, this portion of the frame, which unites the two sides of the ship, has ■ middle seating on the keel, by which arrangement the two ■ of the floor-timber reach equally on each side of the keel.

a b c d is ■ section of the floor-timber, *ef* being the middle line of the ship: to give a steadiment to the floor when

placed across the keel (Fig. 5, p. 11), technically called crossing it, a piece of timber called the rising wood, a section of which, *g i h k*, is shown in the Fig., is worked, to allow of a score or groove being taken out of it; a corresponding one is sunk in the seat of the floor, the double score being sufficiently deep to insure the points *i* and *k* of the timber when let down being brought well to the upper edge of the rabbet of the keel, at *i* and *k*, that the plank may lay on the timber and the edge of it fill the rabbet. In some instances the rising wood is dispensed with, and the floor has for its steadiment ■ coak placed in the seating, part in the floor, and part in the keel (Fig. 6, p. 11).

In the Queen's service, or in the construction of the British navy, the practice is, to have $1\frac{1}{2}$ inch wood in the keel above the rabbet of the keel, under which system of working, $\frac{3}{4}$ ths of an inch is taken out of the keel, and $\frac{1}{4}$ hs of an inch out of the seating of the floor; bringing, as in the old system, the lower side of the floor timber down to the upper edge of the rabbet of the keel, by which ■■■ the seating of the floor on the keel has $\frac{3}{4}$ ths of an inch wood to steady it. The floors are let down mostly by what is called the cutting-down staff, given from the mould-loft floor, which gives the height of the upper side of the throat of the floor at each frame. Some adopt the practice of having what is termed ■ seating line razed on the keel each side, ■■■ standard to measure from, to the seating of each floor on the rising wood.

LONG AND SHORT ARMED FILLING FLOOR OF THE BRITISH NAVY.

The difficulty of the conversion for the floors on the old shift of timber has been attempted to be ameliorated, in the Queen's dockyards, by every other frame of timber, or what is termed a filling frame, being constructed ■ shown by Fig. 9, p. 11. Supposing *a b c d* to be length of the floor described in the first section ■ floors, ■ half shift or butt has been adopted ■ the ■ side as pointed out by the full line.

the ticked line, *gh*, being the corresponding butt on the other side, giving two timbers at the middle line. This certainly would assist the conversion ■■■ all the lower timbers of the frame, floors crossing the keel; but such is not the case, only one-half being so designed. The difficulty in obtaining one-half the lower timbers of this form, combined with the conversion of the floors for the other required half, leaves ■■■ doubt that the system is attended with ■■■ increase of expense, and has not a commensurate advantage in strength.

CROSS PIECES COMBINED WITH HALF FLOORS.

Another method to unite the two sides of the frame of the ship was introduced by the late Sir Robert Seppings, formerly Surveyor of the Navy, and consisted of ■■■ cross piece or short floor across the keel, with two timbers meeting at the middle line of the vessel, denominated half floors. This plan is one uniting strength with economy, and is the combination that ■■■ used in many of the ships now in the Royal Navy. The Fig. 10 will describe the method of putting them together.

The butts of the half floors should be 2 inches alternately on either side of the middle line, to give ■■■ better space for placing the coak or dowel, which ties them to the keelson, ■■■ part of the frame which will be described in the after text. To secure the half floors to the ■■■ piece, and to make the three timbers in their combination nearly equivalent to a solid mass, dowels, or circular coaks, were used of 3 inches in diameter and length, sunk $1\frac{1}{2}$ inch into cross piece or half floor, placed as shown in Fig. 11, p. 11.

These dowels or tenons prevent the surfaces of the ■■■ piece and half floors from sliding over each other, while the bolts placed in each ■■■ of the ■■■ pieces through the half floors effectually prevent a separation of them. The heels of the half floors had also a dowel placed in them, ■■■ described in the section shown by the sketch.

1ST FUTTOCKS.

In the merchant service these timbers run down to the side of the rising wood or dead-wood, leaving a watercourse of the breadth of it or of the keel (Fig. 12, p. 11); in the Queen's service they formerly butted against each other at the middle line similarly to the half floors described in the last section, or Fig. 13.

The practice now adopted in the Queen's service is for these timbers to come to the heads of the cross pieces or floors; and dowels or tenons of hard wood are placed in the heads and heels, as shown in the sketch (Fig. 9, p. 11).

2ND FUTTOCKS.

The 2nd futtocks are placed on the heads of the half floors, and the 3rd futtocks on the heads of the 1st futtocks, the 4th futtocks on the head of the 2nd futtocks, the 5th futtocks on the head of the 3rd and the top timbers on the heads of the 4th timbers, these, with top timbers and lengthening timbers, completing the frame.

PART III.

Room and Space; being the Distance which the Frames of the Ship — placed apart along the Keel, — form the Skeleton of the Ship.

THE distance that the frames should be apart, or the distances denoted by the equidistant straight lines in Fig. 1, p. 11, both in the sheer and half-breadth plans, requires the careful and joint-consideration of the practical builder and the constructor, — having great influence on the weight of the hull and the strength of the fabric; — this essential point the aim should be to have the weight of the hull the least possible that will be compatible with the required strength.

as a diminution of the weight of it, in conjunction with the requisite firmness of fabric, will allow in the merchant service of more cargo being carried to ■ given or proposed draught of water, and in the Queen's service will permit of ■ improvement in form under a proposed displacement or total weight of the ship when equipped for sea; for the total weight of the ship, being equal to the weight of the hull, added to the weight of the provisions, stores, and equipments, a reduction of the weight of hull, ■ of the terms of this equality, with due regard to strength, would admit of ■ less displacement, which would decrease the volume immersed to the proposed draught of water, and enable the constructor to fine the form under water, whereby the propelling power of the sails would have less resistance to overcome, and the speed be increased.

The room and space given in the Queen's service varies from 2 feet ■ inches to ■ feet 9 inches, ■ the space to be occupied by each set of timbers called a frame, which is composed of one cross piece or one floor, two half floors, or two 1st futtocks, two 2nd futtocks, two 3rd futtocks, two 4th futtocks, two 5th futtocks, and two top timbers, with lengthening pieces ■ required to bring the frames to the proposed height.

The room and space has reached to the extent of 8 feet ■ inches in modern times, under the just conclusion, ■ before stated, that ■ decrease in the weight of the hull (all other weights and the form remaining the same) would insure greater speed, to which quality everything else has been made subservient. The equal spaces, when determined, ■ marked on the keel by ■ long measuring rod, called ■ station, or room and space staff, which is furnished from the mould-loft floor or large room, where the drawing of the ship that had been formed on the scale of a quarter of an inch to a foot, is expanded to its full size, or 48 times larger. The joint of the cross piece with the half floor, or of the floor with the first futtock, is kept well to these stations, and the frame's timbers, ■ they go upwards, ■ kept

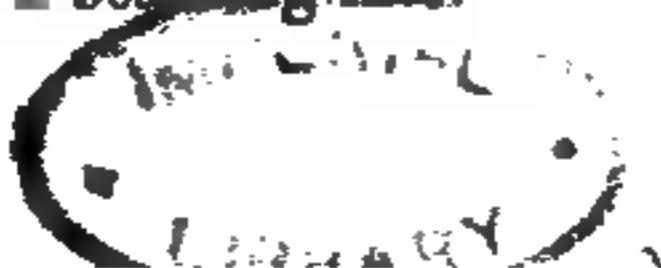
apart from each other according to their respective sidings or thicknesses, leaving at all points equal openings; and the upper timbers being the least in size, the openings aloft ■■■ consequently the largest, but should, if the frame's timbers be well disposed, be nevertheless all equally distant from each other.

PART IV.

Descriptive of the Deadwood.—Apron.—Stemson.—Inner Post.—Cutting down of the Floors.—Raising of the Frames.—Securing the Frames.

DEADWOOD.

THE extremes of the ship, or the fore and after ends of her, having a form given to them that causes the floors' timbers gradually to become more rising or V like in appearance, which renders them first difficult to be obtained, and finally not within the natural growth of timber, it then becomes necessary to have recourse to other methods to continue the assemblage of timbers which compose the frame of a ship. The position in the length of the frame of the ship, where it would be advisable that the component shifts of timbers should be reduced by the floor, must be determined by the practical builder with reference to the capabilities of his store of timber, the half floor and the 2nd futtock of the square body being in the cant bodies cut in one length, and thence called a double futtock: having fixed that point, the deadwood becomes the foundation, against which the heels of the double futtocks and 1st futtocks are abutted. The deadwood is worked of the same width as the keel amidships, and the keel tapering at the fore and after ends, the line of the upper edge of the rabbet necessarily rises up the deadwood, to give the ■■■ breadth where the timber meets the deadwood, thus forming what ■■■ termed ■■■ bearding line.



APRON.

Within the stem, to succour it and afford wood for the reception of the plank of the bottom, and the heels of the foremost timbers, a timber called the apron is worked. The apron may be justly considered as a portion of the fore deadwood, being a continuation of it in a similar way that the stem is a prolongation of the keel; the size of it, in the sided or athwartship direction, is the same as that of the stem, and in large ships, where from necessity it is composed of two pieces, the scarf by which it is united is made to give shift to those of the stem: by shift is meant that it is placed intermediate between the scarfs of the keel and stem, to ensure the greatest strength under the required combination of materials.

The scarf of the apron is doweled and bolted to itself at the lips or ends, the middle of the scarf being left for the bolts of the stem, and of the knee of the head to pass through. The apron is also doweled to the stem, as shown in the sketch (Fig. 8, p. 11).

STEMSON.

The stemson is a timber worked on further support to the stem (Fig. 8), and the three—stem, apron, and stemson—form a mass of timber that is subdivided in conversion, from the impossibility of obtaining one timber for the whole, either to the size or the curvature required.

INNER POST.

The inner post bears the same analogy to the main post that the apron and stemson do to the stem, and may be considered the continuation of the after deadwood, to form a foundation for the reception of the plank, to succour the main post, and receive the heels of the extreme after timbers. With a view to the further support of the main post, considered as being united to the inner post, and forming with it

one mass, a groove is taken out at the middle line on the fore side of the inner post; and the after end of each layer of deadwood has a corresponding tenon raised in it, which being dropped into the groove in the inner post, forms a steadiment to the two posts or mass of timber in the athwartship direction.

CUTTING DOWN OF THE FLOORS, OR THE HEIGHT OF THEIR THROATING OR UPPER SIDES OF THEM FROM THE LOWER EDGE OF THE RABBET OF THE KEEL.

e f, cutting down (Fig. 5, p. 11) of the midship floor, or height of the upper side of the floor above the rabbet of the keel.

The throating or moulding usually given to the midship floor, is once-and-a-half of their siding or thickness; and to determine the height of the cutting down, and thence throating of the foremost and aftermost floors, the scantling or size of the timber is described on the mould-loft floor, and the height is there determined that will give the moulding that is thought sufficiently strong for the ship, and practicable of conversion from the store of timber.

In the foremost floor (Fig. 14, p. 11), *g e*, is the form of the floor to the outside of the timber, ■ shown on the mould-loft floor, ■ *b* the form given to the inside of the timber ensuring the scantling or size ■ *g*, then *a f* becomes the height of the cutting down for the foremost floor. In the same manner the height of the cutting down (*c d*) for the after floor is determined so as to obtain the square scantling (*h c*). A batten passed through these three points, viz., the midship one, and the two fixed as here described, will give the height of the cutting down for all the floors, and, continued beyond them to the stem and stern-post, will form the height of deadwood necessary for the reception of the heels of the fore and after timbers of the frame of the ship, or those of the fore and after cant bodies of her.

RAISING THE FRAMES, OR A DEVELOPMENT OF THE FORM OF
THE SHIP BY THE RIBS ■■■ FRAMES BEING PLACED ACROSS
THE KEEL.

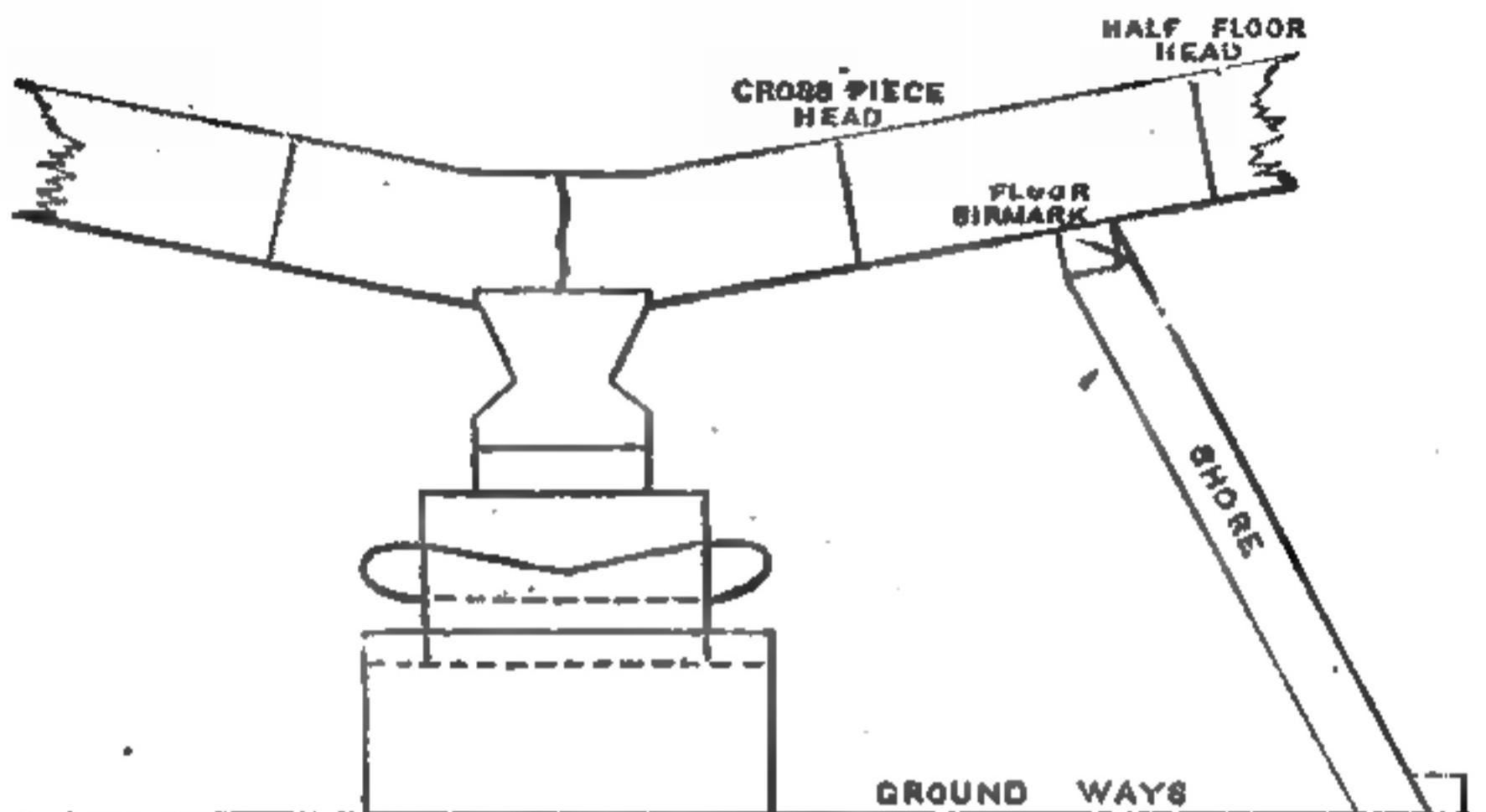
The several assemblages of cross pieces and half floors, floors, and 1st futtocks, or long and short arm floors, as the practical carpentry may be, ■■■ first what is technically called crossed, that is, placed athwart the keel at their respective stations. They ■■■ let down to their cutting-downs by means of the depths given from the mould-loft, ■■■ what is termed ■■■ cutting-down staff, and they ■■■ squared ■■■ the keel by using a long staff as a measure from the middle line of the keel to a given station on each arm of the floor or half floors; and to set them perpendicular to the keel, ■■■ level and plumb is used, by having a long straight batten placed from arm to arm of floor or half floor at ■■■ given mark or station.

1st. To hold them in this position, the floor ribbands, or pieces of square fir, of 5 inches by 5 inches, ■■■ then brought round the outside of the floor timbers at a given height marked on each floor arm ■■■ floor sirmark, which station is given by the moulds from the mould-loft floor, and cut in on the timbers when worked or trimmed; these secure the heads of the floors in position, and are well shored to the bottom of the slipway, the head of each shore being scored over the ribband, and a nail placed in it. The ribbands are secured to the frames in the Queen's service by eye bolts, have ■■■ screw thread in a portion of them; they were introduced into the service by Mr. Blake, late master shipwright of Portsmouth Dockyard, and are invaluable for mechanical purposes.

2nd. The assemblage of timbers composed of 1st futtocks and 2nd futtocks, &c., are put together on the ground or slipway, and bolted with frame bolts of iron to constitute each frame (see sketch, p. 25), and they are hoisted into position over the heads of their respective floors by the means of large sheers, formed of pieces of wood called hand masts;

the bag of each frame, or the curvature of it, being preserved ; as pointed out by the sketch (Plate 5, Fig. 9).

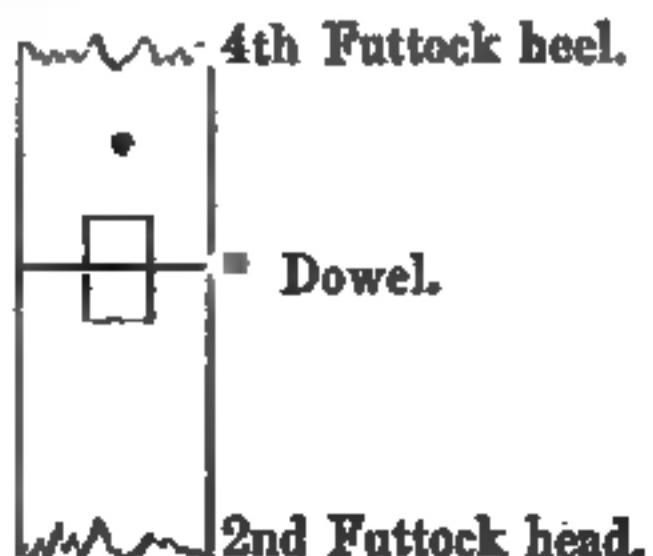
Section of Building Blocks, Keel, and Floor.

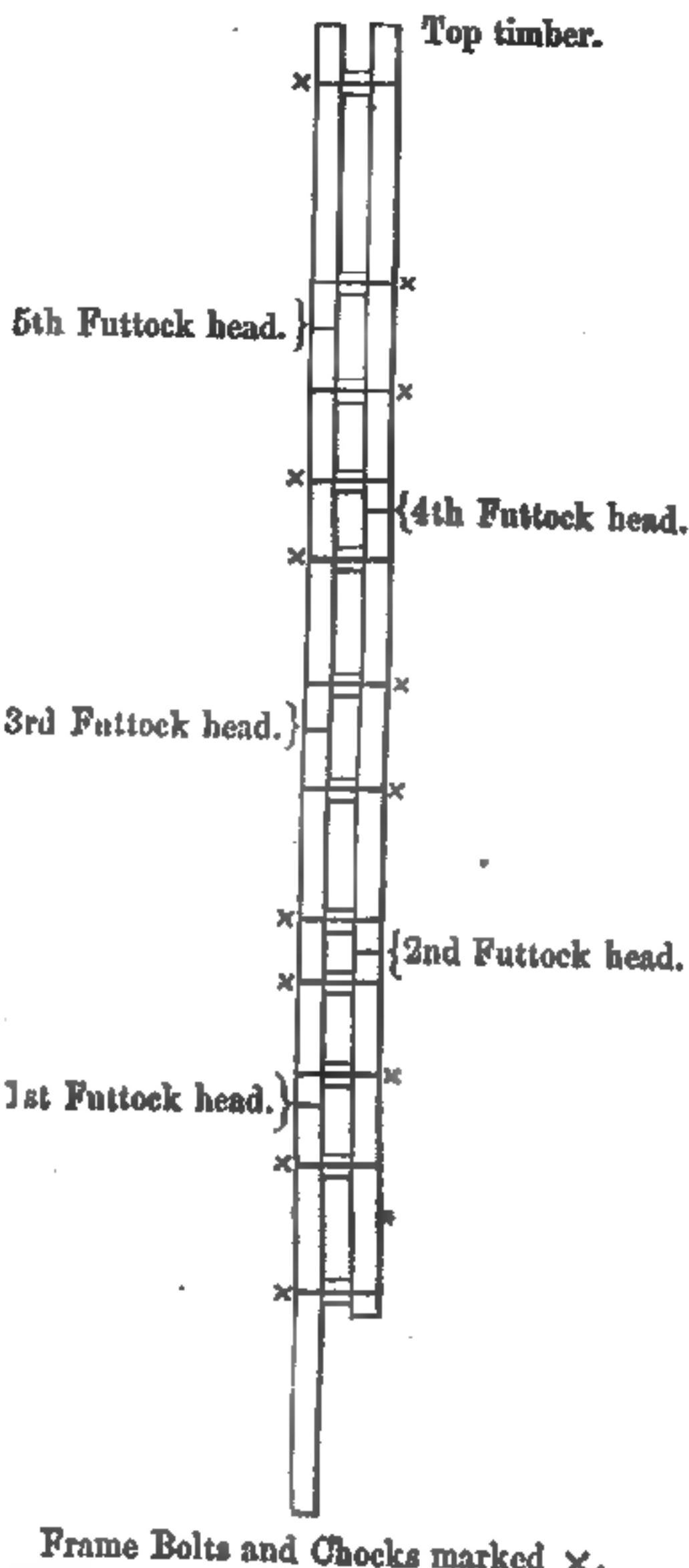


The continuations of the ribbands beyond the square frames are called harpins, and require from their curvature and form to be trimmed to receive the after and fore timbers, which are denominated cant timbers ; the ribbands and harpins are sometimes scarphed to each other, but the connection is the more usually kept up, by one length of the ribband being made to overrun the other.

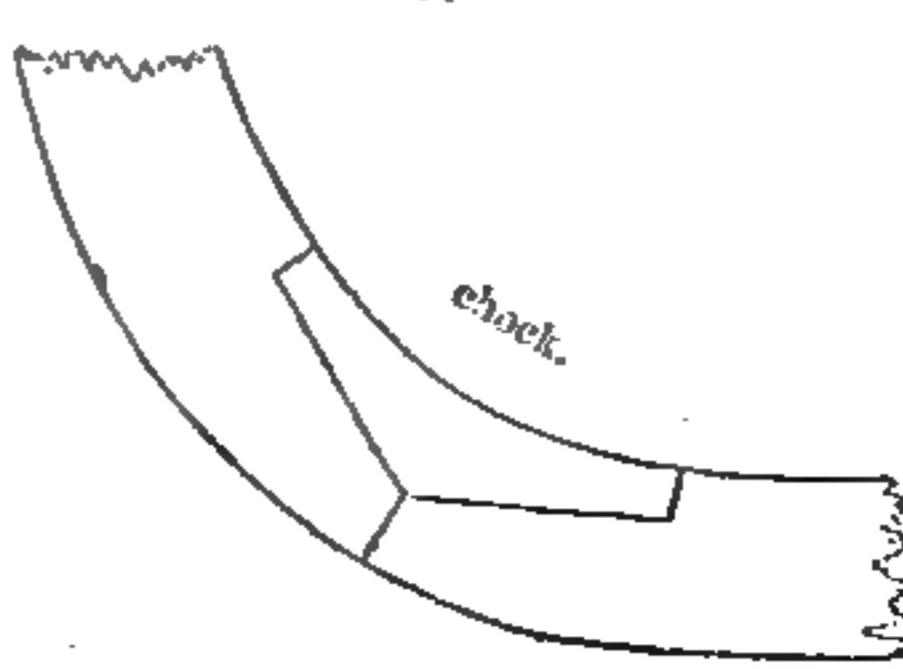
The consecutive ends of the timbers are dowelled to each other, the dowels being 3 inches long, giving $1\frac{1}{2}$ inch into each timber thus :—

Section of the Timbers showing the Dowel.





In the merchant service, and formerly in the Queen's service, the heads and heels of the consecutive timbers — united by chocks, as shown by the sketch—thus. This method assists in the conversion of the timber, the



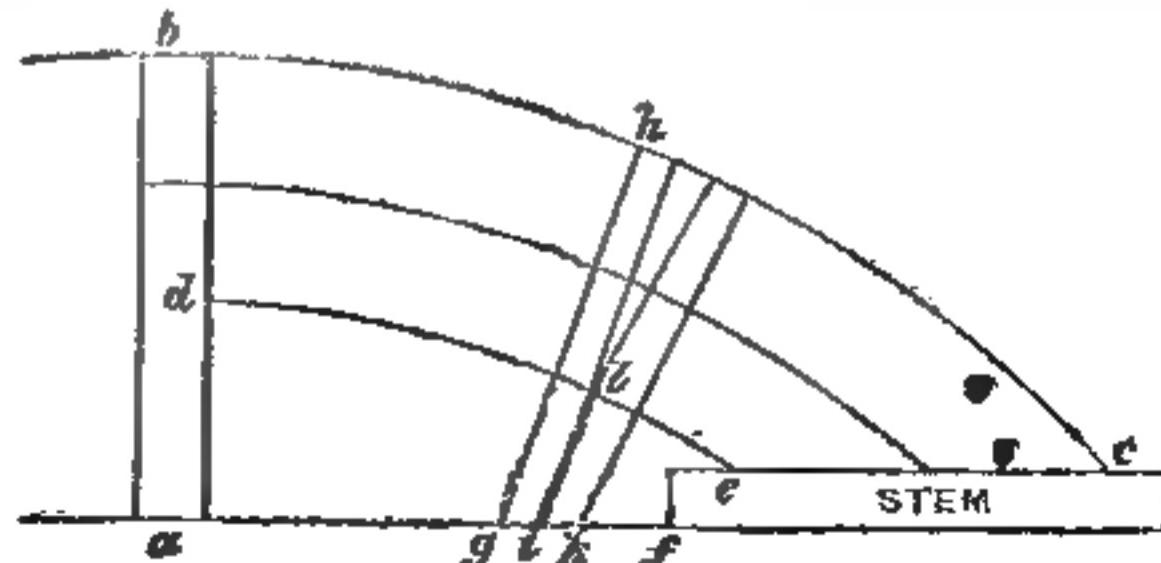
chock supplying the deficiency of the wood required to form the square butt; but the chocks were found to subject the frame to early decay, and a moderately increased first expense to the Government is not to be considered, when efficiency and durability is at stake. There is a difference in opinion on this arrangement, a further detail of which is not within the limits of this small work.

PART V.

Description of the Fore Cant Timbers of the Frame.—Their Use.—Stem Pieces.—After Cant Timbers.—Changes in them in the Navy of this Country.—Keelson or internal Keel.—Side Keelson.

CANT TIMBERS OF THE FRAME.

THE immersed portions of the extreme ends of a ship, or her bows and quarters, are rounded off; in the fore extreme or bow, to give the ship a form that will divide the water with ease when it is propelled by the sails; and in the after extreme, which is termed the quarters, the body immersed is made fine to allow the water to pass to the rudder in a line with the keel of the vessel, to insure the full effect of steerage or the government of her motions by the rudder, by which adaptation of form the space aloft is made considerably larger than below; under these circumstances the square timbers, or frames, that have been described, could not be continued the whole length of the vessel, with due regard to strength and economy, and thence recourse has been had to a disposition of the frame, called cant timbers, a cursory description of which arrangement will now be given.



• *a b* is the foremost square timber as it would be depicted on the half-breadth projection of the ship plan or drawing; and here, perhaps, no better illustration can be given to this mystical device of the shipbuilder, than to compare his drawings with the paper mouse-trap of our younger days; in the plaything, the succession of circles while on the surface of the card board seemed without substance or form; but by raising the internal and smallest circle we gradually drew each successive circle from the board, and ■ paper mouse-trap ■ to ■ then wondering eyes. Thus it is with the shipbuilder's plans. The lines there delineated, require to be raised by the mind above the paper on which they are drawn to the required distances apart, to form a diminutive representation of the vast structure which it is now attempted to make familiar to the uninitiated, and to place the practical carpentry of it within the intelligence of the school-boy.

With respect to the cant timbers, or the filling of the space between the square frame *a b* and the stem at *c*, it may be compared to the staves of half ■ cask, or that departing from the direction of the sides of the timbers which form the square ■ athwartship body, and which timbers have their sides vertical and athwartships; the cant timbers, keeping their sides still vertical, have gradually to be inclined to 90° , or a quarter of a circle, to meet the stem, the plane of whose sides or siding way is fore and aft; the heels of them also have ■ less space, ■ *af*, for their reception, which causes the practical builder to reduce the cant timbers in their siding or thickness at the heels, to make them close joints, or, indeed, angle against each other, from ■ given point, taking the wood away partly from each. Thus at *g h* they are made to cross on *d e*, at some point *l*, or to open at an angle both ways from that point, the heels of each at the deadwood being reduced by the substance, that the directions of the timbers give, in crossing each other at the deadwood, ■ *i l*.

Against the stem it is usual in the Queen's service to work ■ angled or shaped timber called the stem piece, having for

its object the increasing the distance between the knightheads, or first cant timbers — each side from the stem. The knightheads form the sides of the seat or bed for the reception of the bowsprit*, the stem-head forming the bed; and they would without this precaution be weakened by the hole required for the bowsprit being — in diameter than the thickness of the stem, which would deeply cut into the knightheads if the stem pieces were not worked. The next timbers to the knightheads — the hawse timbers, worked for the reception of the hawse holes; they had formerly filling timbers worked between them, with the butts of them coming in the hawse holes, to prevent (as in the case of the knightheads) their being weakened by the holes cut through them for the hawse pipes in which the cables are used. The remaining cant timbers are frames of timber only for the form and strength of the vessel.

AFTER CANT TIMBERS.

The explanation given for the disposition of the fore cant timbers will apply to all but the extreme after timbers, and here the ingenuity of the modern practical builder has been allowed to show itself in all sorts of systems. The form given to the extreme after part of the ship, in former times, was universally what is termed ■ square stern, and under this shape the vessels used for commerce present themselves to this day: not so in the Queen's service; there, each year of this latter age has witnessed fancied or real improvement in the stern, when attained at ■ vast public expense, superseded, it might almost be said, from ■ desire for change in the rulers of the naval dynasty of this great maritime country. And ■ ■ impartial review of the navy of this country for these 25 years past it will be found, that square sterns ■■■ pulled down to make room for circular ones, and that these

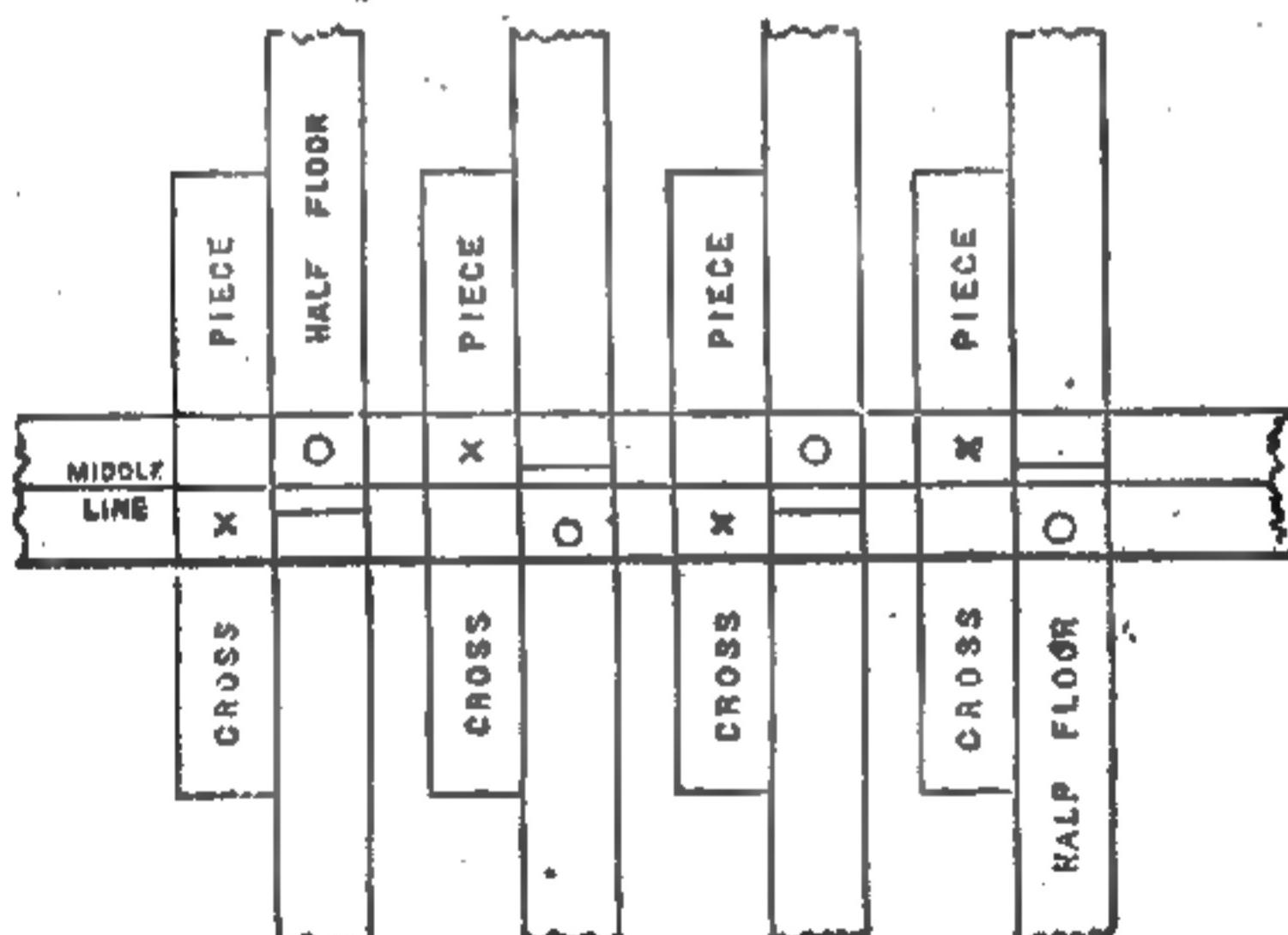
* The bowsprit is ■ large spar used as an out-rigger, projecting beyond the fore extreme of the ship, on which the head or foremost sails are extended ■ set.

circular ones in the same ships, have in their turn given way to those of ■ elliptical form, and the day may not be far distant when the chain of changes may be completed by a return to the original square stern.

KEELSON.

The keelson, ■ denoted by the name given to it, may be considered as ■ internal keel worked with the view of strengthening the vessel lengthways, and, in conjunction with the keel, confining the floors in their respective stations. The bolts of the keelson are driven through the throat of each floor and through the main keel. The keelson is in ships of the

Disposition of the Fastening in the Keelson.

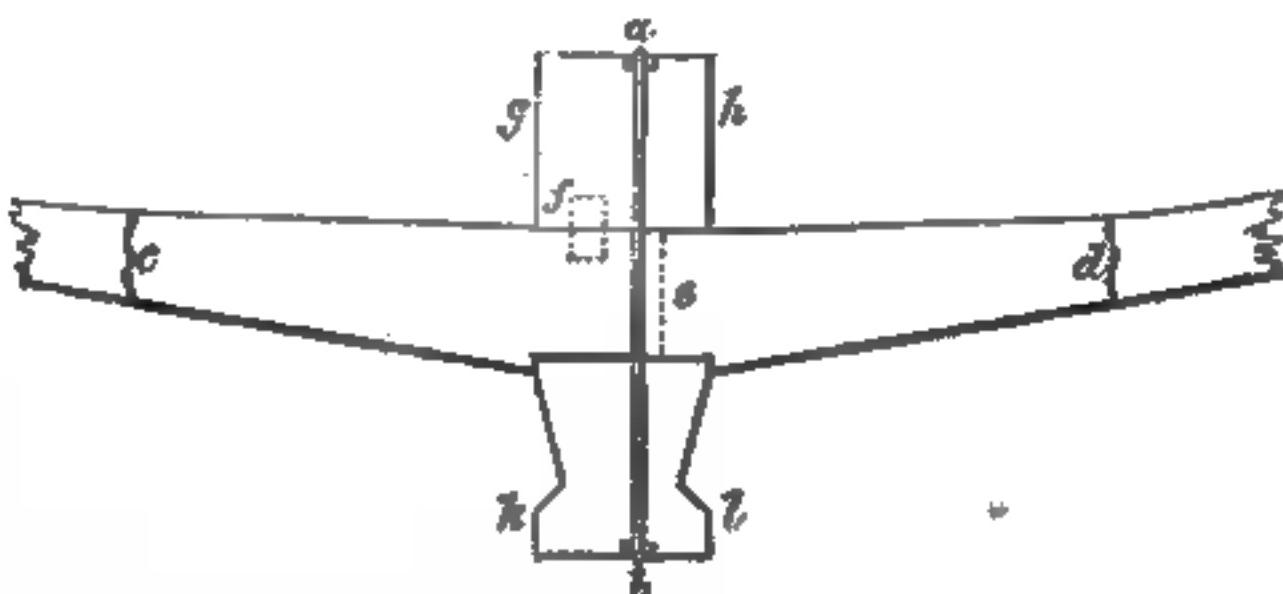


○ Coak or Dowel. X Bolt.

navy coaked or dowelled to the half floor or 1st futtock of each frame; and, for the better reception of these dowels, the half floors are not butted or joined at the middle line of the vessel, the excess being made ■ the alternate sides to assist in the disposal of the coaks. The keelson, in scantling or dimensions, is the square of the siding, or athwartship way of the ship, divided into four parts, the latter being determined

by a due regard to the store of timber, and the giving shift overlaunching to the scarpes of the keel: the centres of the masts, and the fore and aftermost pieces should extend beyond the foremost and aftermost floors of the square body, to connect the keelson with the deadwood.

Sketch showing the Section of a Cross-piece, Keelson, and Half Floors.



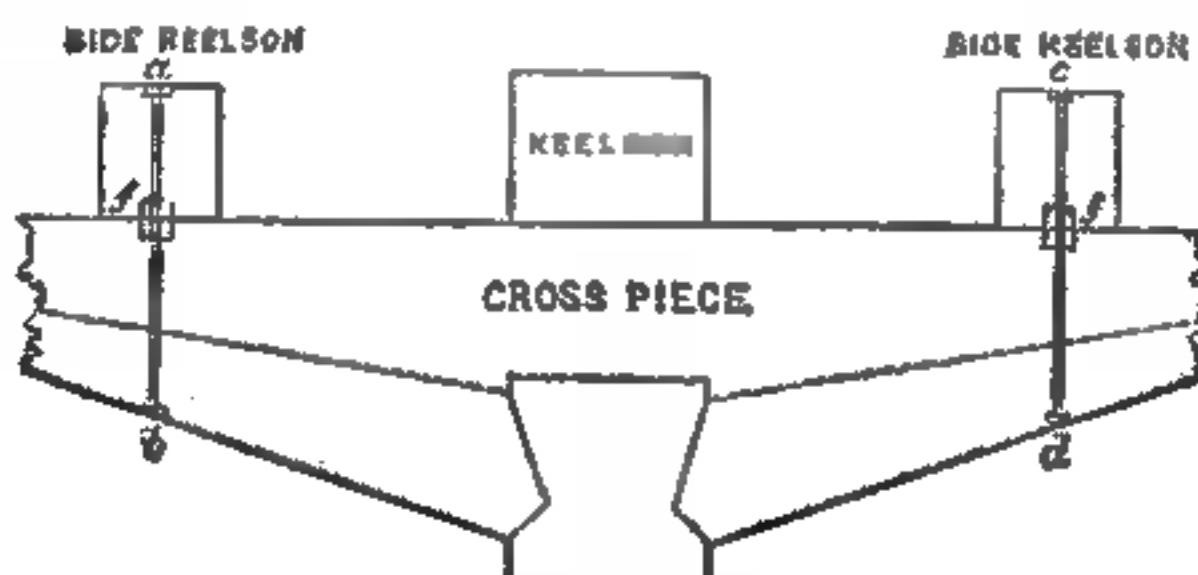
g h keelson, in form square, and in dimensions the siding or width of the keel (*k l*); *c* and *d*, the heads of the cross-piece, *e*, the butt of the half floors placed on the one side of the middle line to admit of a coak *f* in the keelson being used clear of the butt (*e*); *a b*, keelson bolt, passing through the keelson, cross-piece, and keel: the bolt should be placed either side of the middle line for greater stediment to the combination—the limit to the spread of the keelson bolts being such that the bolt may not break out in the rabbet of the keel. In the merchant service the keelson is bolted as described for the man-of-war, but dowels are not used, as the heels of the 1st fattocks do not come to the middle line of the vessel. The keelson bolts are of copper, and vary in diameter, according to the tonnage of the vessel, from $1\frac{1}{2}$ inch to $\frac{7}{8}$ ths of inch. These bolts are driven on a ring of mixed metal, and the copper being beat out by driving, a head is formed larger than the ring, forming a hold when driven, beyond the friction of the bolt, which tie to the keel is completed, by the point of the bolt being spread over a ring let into the under side of the main keel;

this arrangement of the fastening unites firmly the keelson and keel together through the medium of the cross-pieces and half floors. The rings — shown in the sketch at the head (*a*) and point (*b*) of the bolt (*a b*).

Watercourses or gutters should be formed under the keelson and side keelsons, which is effected by the fillings being less moulded than the timbers. See description of Plate 2.

SIDE KEELSON.

In the Queen's service, inside the frame of the ship, abreast the main-mast and about 6 feet on each side from the middle line of the ship, timbers called side or sister keelsons are worked, the intention of them being to strengthen the ship in the immediate vicinity of the main or principal mast, the step to receive the mast resting in part on these auxiliaries to the main keelson. The lengths of the side keelsons vary from 30 to 50 feet, according to the size of the ship. The siding and moulding of them is usually 2 inches less than those given to the keelson itself; they are bolted with copper bolts through the timbers of the frame and the plank of the bottom, these bolts forming part of the fastening of the outside planking.



In the sketch, the sections of the side keelsons and main-keelson show their relative positions and their security through each alternate timber of the frame; *a b* and *c d* being the bolts, forming also a portion of the fastening of the bottom plank. These keelsons are also dowelled to the timbers of the

ship ; the dowels, as *f*, being placed in those timbers which do not receive a bolt, and ■■■ in number such ■■■ to be from 6 to 8 feet apart.

PART VI.

Fillings between the Frame of the Ship.—Introduction of them by Sir Robert Seppings.—Their intended Use.—The Methods first adopted, and that at present pursued, in her Majesty's Dockyards.

SIR Robert Seppings, ■ late Surveyor of the Navy, proposed that the frames of H. M. ships, to ■ certain height from the keel, should be made water-tight, independently of the outside planking, to the desirable end that, in the event of the ship striking the ground, and the outside planking being forced off or being seriously damaged, the vessel would still float. In addition to the important advantages to be obtained from this mode of practical construction, as tending to the preservation of life and property, the projector had further in view the increase of strength given to the ship by her being thus made, as it were, a solid ■■■ of material below the water. It is found in practice, from the form given to the bow and quarters under the water being fine or sharp to ensure velocity in sailing, that these extreme portions of the ship are not water borne ; and that thence the midship volume displaced must, to make up the whole displacement or weight, be on the contrary greater than equivalent to the weights placed over it. The results which arise from this inequality between the superincumbent weights and the upward pressure of the water are practically evidenced by the falling of the extremes and the rising of the middle of the vessel, causing the keel of the ship after she has been ■■■ time afloat to assume ■ curved form, which is technically termed hogging. To take this altered position in the water, theory points out, and experience confirms, that the materials below ■ certain point in the depth of the vessel, and above the water-line,

materials used, and the ■■■■■ perfect their combination in building, the less alteration there would be in the form of the vessel when floated.

To effect this firmness of fabric, Sir R. Seppings at first filled in all the openings, below the water, between the frames or ribs of the ship, with bricks and mortar between cants of wood, and in after times with cement made of sand and water, or sand and coal-tar; but these preparations for fillings were found to be the fruitful ■■■■■ of early decay to the frame-timbers of the ship, and ■■■■■ thence abandoned; but the system ■■■■■ proved correct in principle, and the usual practice in Her Majesty's service is wholly to fill these openings with sound and well-seasoned fillings of wood. The fillings extend in some instances from the middle line of the ship at the keel to the load line or line of supposed deepest immersion; but they do not hold their moulding to that height, being gradually reduced in size to half the moulded breadth of the timbers at the upper line of them, they being made on the outside fair with the timbers of the frame. This gives a watercourse (Plate 2), under the internal planking, for the drainage of the water arising from leakage or otherwise to the limbers (p. 47); the main pipe, ■■■■■ it were, communicating with the pumps. It only remains to be added that the fillings ■■■■■ caulked inside and outside previously to the internal and external plank being brought on, thus making them watertight, that the vessel may float or swim should the outside planking of her be injured by the ship striking the ground.

PART VII.

Internal Trussing.—Introduction of it by Sir Robert Seppings—Stability or Firmness of it.—Remarks ■■■■■ the Views taken of it by the Directors—Former and the latter Systems of Trussing the Ships of the Royal Navy contrasted.

THE late Sir Robert Seppings also introduced into the

RUDIMENTARY TREATISE

a substitute for a portion of the internal planking, ■ combination of wood-trussing to strengthen the ship, and illustrated the intended effect on her by a reference to the stability given to a five-barred or other gate by the bar which is placed

■ the horizontal portions of it. The illustration would have held good, had the strain (which he, in common with others, knew was brought on the gate) been similar to that to which his trussed frame in the hold of the ship ■ subjected. In the gate, the stiffness being required in the vertical position of it, the cross-bar is made wholly effective; but the same gate would be found very weak if its strength were tested by ■ force being applied to bend it horizontally or the flat way. This trussing frame, called by its projector ■ diagonal frame, ■ composed of timbers nearly equal in dimensions to the lower timbers of the ship, and might be justly termed ■ internal frame, disposed diagonally or similarly to the cross-bar of the gate, as being athwart the frame of the ship; but in the lower part or near the keelson, this trussing, in flat-floored vessels, was wholly out of comparison with the vertical position of the bar of the gate, and in those ships having a rising or sharp floor it only approximated to it. The diagonal framing thence became nearly useless ■ a truss, and its beneficial effects were confined to uniting the several timbers of the frame together in ■ longitudinal direction. This framing also, in practice, ■ found to interfere with the stowage in the hold; to be subject to early decay, the more especially so where old ship timber was used for this purpose; ■ originally suggested by the projector; and, moreover, to yield little strength to the carpentry of the ship. Such practical results, combined with some share of the love of change in the successors of Sir Robert Seppings, led to the introduction of the present mode of tying the frame timbers to each other by ■ succession of iron plates (Plate 2), as a substitute for the former wood frame. These iron plates vary in size according to the rate or tonnage of the vessel, their thickness being

inches; their lengths in ■■■ cases extending from within a short distance of the keelson to the top sides or upper part of the vessel*.

The mode of working these plates has been the subject of much controversy among the practical builders of the navy. In some instances they have been bent to the inside of the timbers without being inserted into them; while in others they have been buried half their thickness in the frame timbers, and, in ■■■ cases, the practice has been sanctioned of letting them in their whole thickness: but surely the insertion of them into the frame must be erroneous,—the frame of a large ship is always difficult to obtain the moulding way, and the axiom of nothing being stronger than its weakest part, would cause the practical builder to ponder well before he weakened the frame of his ship, by the score necessary to receive a plate that has little tendency, when worked, beyond the stringing, as it were, of the timbers of that frame together. These plates are bolted through the frame timbers and outside plank; and the bolts in them should form part of the regular fastening of the bottom. In small vessels these iron riders are screwed to the frame timbers by short screws, in the alternate holes; and it is advisable, in all vessels secured by this system, to work these iron riders before the outside plank is brought to, securing them temporarily with the screws; for the timbers of the frame being in some degree united by them, these plates will then prevent the edge sets used in planking, from separating the heads and heels of the several assemblages of timbers which constitute ■ frame or rib, and produce ■ desirable result; for, if such ■ separation takes place to any considerable extent, the stiffness of the frame is in a great degree destroyed, ■ the heads and heels

* The iron plates or riders at the top sides should be reduced in thickness, in the midship portion of the ship; and at the extremes, or the bows and quarters of the vessel, both upper and lower riders should be reduced both

■ then, and will, work over each other when the ship is acted on by the force of the sea.

Sketches showing ■ compartment of the diagonal frame or iron truss frame of the present time are subjoined (Plate 2).

In the merchant service this system of truss frame has never been generally adopted, from the great additional expense attending its use; but in the year 1822 two vessels were built by Messrs. Gordon of Deptford, having the principle of wood trussing applied to their practical building under ■ most advantageous form. A system of trusses was placed between the lower and upper decks, where the sides of the ship were quite straight in the fore and aft way, and vertical in the up and down. The body ■ thus made, as it were, rigid or immovable to change of form at that part, and the rest of the structure might be considered to be secured from deflection or breaking, by being attached to the unalterable combination of this portion of the ship. The expense incurred by this system of building prevented its being followed generally in the mercantile navy; but Mr. Lang, master shipwright of Woolwich, has with great success applied the diagonal frame under the same principle to the Trafalgar and Royal Albert, first-rates, each of 120 guns, and probably Mr. Lang may have made the original application of the system to such purposes.

PART VIII.

Shelf ■ internal Hoop.—May be considered as a Portion of the internal Planking worked to receive the Ends of the Beams.—Sections showing the relative Position of it with the Frame of the Ship.—Description of the Security used for it.

SHELF.

AT the height of the under side of the beams which receive the several decks or platforms of the ships in the Royal Navy, internal ribs of wood are worked longitudinally, the whole length of the vessel, to receive the ends of the beams, and

of the internal planking of the frame, and are usually brought about or worked, but not bolted, before the outside plank is brought to, forming a good internal ribband, to preserve the form of the ship while the outside plank is being worked, Mr. Blake's screws being usually employed to keep it temporarily in position.

Sketch No. 1 shows the section of the frame timber, shelf, and beam, as usually practised. The shelf is composed of several lengths or shifts; the one being scarphed to the other by vertical scarphs, the length of the scarphs being governed by their being made equal in extent to two (p. 17)

Fig. 1.

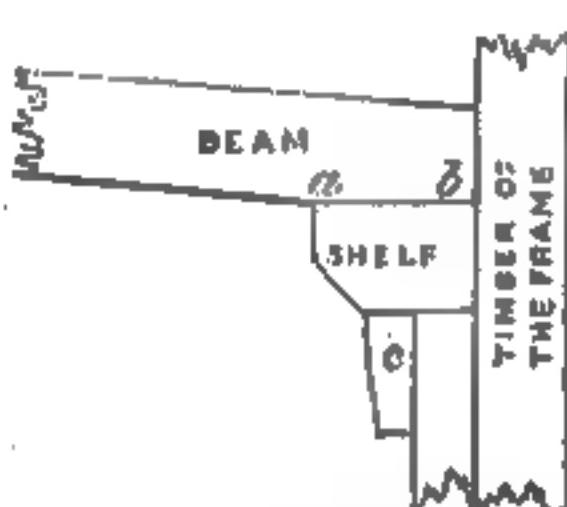
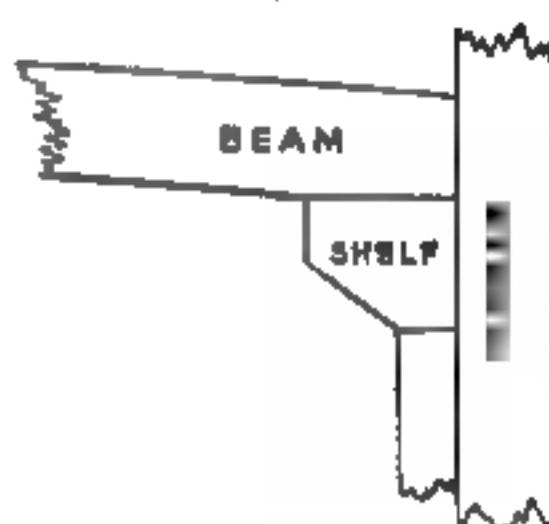


Fig. 2.

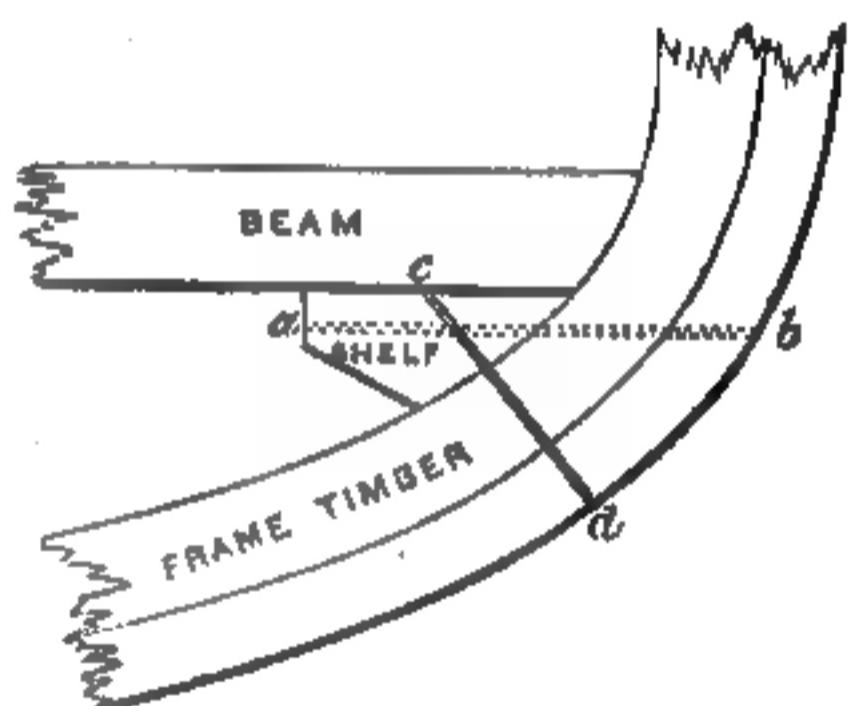


portions of the room and space given to the timbers of the frame. The scarphs are coaked or dowelled together with three dowels, and on bolting the shelf one bolt is generally placed through it at each frame timber, except forward and aft, where the distance between these bolts varies from 2 feet 6 inches to 3 feet; the upper surface of the shelf *a b*, on which the beam end rests, should be below a level, to prevent lodgement of water. Fig. 2 is a section showing the method used by Mr. Lang, master shipwright of Woolwich Yard, in working the shelf, as doing away with the chocks, which are necessary in the plan, Fig. 1, to receive the iron knees that unite the ends of the beams to the sides of the ship (Plate 2); this arrangement will be again adverted to when that part of the structure is described. The bolts used for the shelf are of copper, varying in diameter from $\frac{3}{4}$ ths of an inch to $1\frac{1}{4}$ inch, according to the tonnage of the ship and the thickness of the timber.

shelf is worked. These bolts should form part of the regular fastening of the outside planking, and should be placed ■ nearly square to it as the nature of the work will admit; for it should carefully be kept in view that the shortest fastening through a given or fixed thickness is to be preferred, ■ embracing twofold advantages—that of strength, together with economy in the use of such expensive material as copper; and also, that a reduction of copper bolts in length, with no diminution in the firmness of the hull, is attended with the best result to the naval constructor—the maximum lightness of the hull of the ship. To exemplify this, the accompanying sketch is given as descriptive of the lower shelf of most ships, the shelf laying oblique to the timber of the frame.

a b the usual level bolt, cutting the outside plank obliquely.

c d the bolt placed square to the outside planking, shorter than *a b*, more square to the seating of the shelf on the timbers, and thence a stronger and cheaper fastening.



PART IX.

Planking, or placing the Skin ■ the Skeleton or Frame.—Preliminary

Remarks.—Description of the outside Plank, considered in the several Denominations, of Wales or Bends, Diminishing Plank, Plank of the Bottom, and Garboard Strakes, with the Methods of converting and working them.

TO COVER WITH THE PLANK.

THE frame having been completed in harpins and ribbands, and the shelf worked ■ described, the skinning or

ON SHIP BUILDING.

or bends, marked N (Plate 2), which are the thickest planks worked on the ship, is first razed on the timbers by means of long battens, technically called sheer battens, the best situation for them having been beforehand determined by the practical builder on his drawing; and it must here be advanced that the careful and intelligent practical architect will, for economy, strength, and the perfection of his work, build his vessel on paper from his drawings and from the sections he ■■■ make from those drawings. The conversant eye of ■ draughtsman, under such circumstances, ■■■ with advantage and accuracy ■■■ over the miniature of the ship, ■ shown by his plans; he can by them determine the relative positions of the several parts of the vast fabric, and ensure to them the maximum or greatest strength of combination with the least quantity of materials. These remarks ■ intended to relate more especially to the fastenings which ■ to pass through the bottom plank of the ship, which should be wholly disposed of on paper, to avoid over fastening, which causes weakness in the vessel from two considerations—unnecessary perforation, or boring of the timbers of the frame, and the additional weight given to it, from the fastening, whether iron or copper, being in weight more than the wood taken out to receive them.

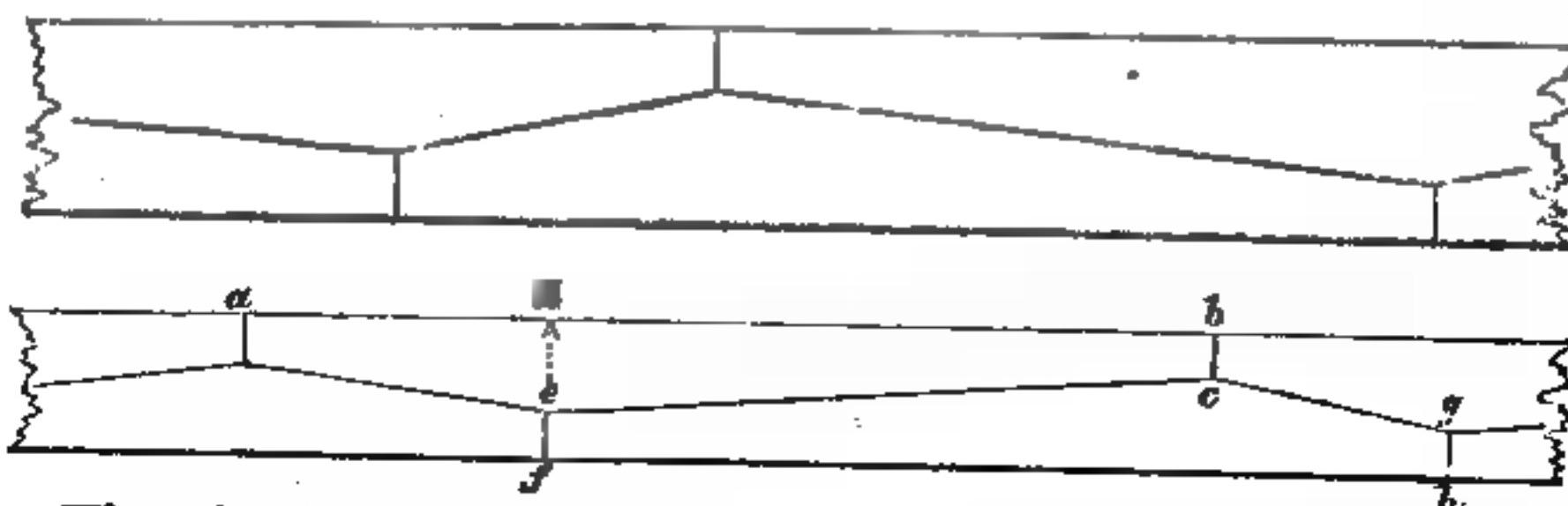
WALES AND PLANK OF THE BOTTOM.

The frame of the ship, previously to the plank being worked, should be set perpendicular by dropping ■ plumb-line from the centre of the cross-pauls, when the point of the brass or plumb should agree with the middle line of the ship, razed in or marked in upon the upper side of the keelson: if it should not do so, the shores placed to the ribbands should be slackened or loosened on the ■■■ side and taughened or driven up on the other, until the point of the plumb touches the middle line before described.

The Cross-Pauls are drawn in full in Plate 1.

they ■■■ secured to the timbers at their stations, to preserve the form of the ship while she remains in frame, and until the beams are crossed.

The bends or wales of the ships in the Queen's service are usually of English oak, called, in shipwright phraseology, thickstuff, running from $4\frac{1}{2}$ inches in thickness, in small vessels, to 10 inches in first-rates. A representation of the plank, or what is termed a shift of the butts of the plank, is made on paper by the draughtsman or practical builder, who, in making it, must have a cautious reference to the store of thickstuff and plank at his command before he determines the lengths of the plank or shifts to be used in building the vessel, that he may not have difficulties to overcome from the number of planks he will require of ■■■ assumed over length. The ports in ships of war will require consideration when determining the butts of the wales*. The English plank and thickstuff, from being cut out of trees wide at the butts or lower ends and narrow at the top ends, partake of the character of the tree, and thence for economy and good conversion require to be worked in ■■■ peculiar manner, denominated top and butt, or the bringing the butt of the one plank to the top of the other, to make up ■■■ constant breadth in two layers, ■■■ shown in the figure below.



Thus in the two planks, *a c* and *e h*, the width of the two being 2 feet, it is usual to work what is called the touch (*d e*) 15 inches, leaving the top *e f* of lower layer *g h* to be 9 inches, to complete the assumed width of 24 inches, or, if it will assist

* With reference to having each plank or shift of them in length, the

conversion, these may be altered to 14 inches and 10 inches, making 24 inches. The touch ■ is taken at $\frac{1}{4}$ th the whole length of the plank from the butt end. This arrangement gives the edges of every other plank parallel to each other, styled fair edges. Sometimes English oak plank and thick-stuff is worked what is termed Anchor Stock, but this should be resorted to only when extreme cases require it, from the extravagance of the conversion; it may, however, be worked with advantage in the channel wales of line-of-battle ships, and the spirketting of them and that of frigates.

Sketch of two Layers of Plank-worked Anchor Stock.



The thickstuff is lined for anchor-stock conversion by its being made to hold its greatest width in the middle of its length, as ef , when the width of the top end, ■ $a c$, will determine the reduction to be made in the butt end ($b d$), $b d$ being made equal to $a c$, and the points c and f , ■ and f , being joined, will give the form of the plank; and the under layer will be of the same shape, giving the width of the two together ■ that which would result from adding the breadth which the plank will hold in the middle of its length to ■ similar width at the top end. This method gives also a fair edge or line for every two layers of plank worked. From the lower edge of the wales, the width of which in large ships extends to 14 or 16 strakes, the planks have to be diminished in thickness, to meet the intended or given thickness for the plank of the bottom. Thus, in the first-rate, where the wales are 10 inches in thickness and the bottom plank 5 inches, the planks following immediately under the wales have gradually to be reduced in thickness from 10 to 5 inches: the planks which ■ worked to effect this graduation in thickness are techni-

adopted to regulate the decrease is to strike two lines as tapering lines ■ follows :—

							Under side	Upper side
10	1	2	3	4	5	6	7	6
of wales.								of bottom.

The diminishing plank being, in the Queen's service, of English oak, is worked top and butt for economy, whence each of the sections marked 1, 2, 3, &c., contains two layers of the depth, giving in this example 14 planks to effect the diminution from 10 to 5 inches, or nearly $\frac{1}{4}$ ths of an inch difference between the upper and lower edges of every two consecutive planks, or the fair edges of the planks, considered as being worked on the top and butt system.

The plank of the bottom extends from the diminishing plank to within five or six strakes of the keel, these latter being of elm, and are termed the garboard strakes; the plank of the bottom below the diminishing plank, ■ far as the supposed light draught of water, or the immersion of the vessel before any weights or stores ■ placed in her, is, in the Queen's service, usually of Dantzic oak plank, the remainder of the bottom being of fir to the garboard strakes. In the merchant service, the bottom plank is often ■ mixture of fir, American elm, and English elm.

The fir strakes, in the Queen's service, have invariably the after shifts or hoods of oak, for the better security of the stern-post and rudder, and the fore shifts or fore hoods ■ of the ■ material where the form of the bow requires the plank to have a great curvature ■ twist in it.

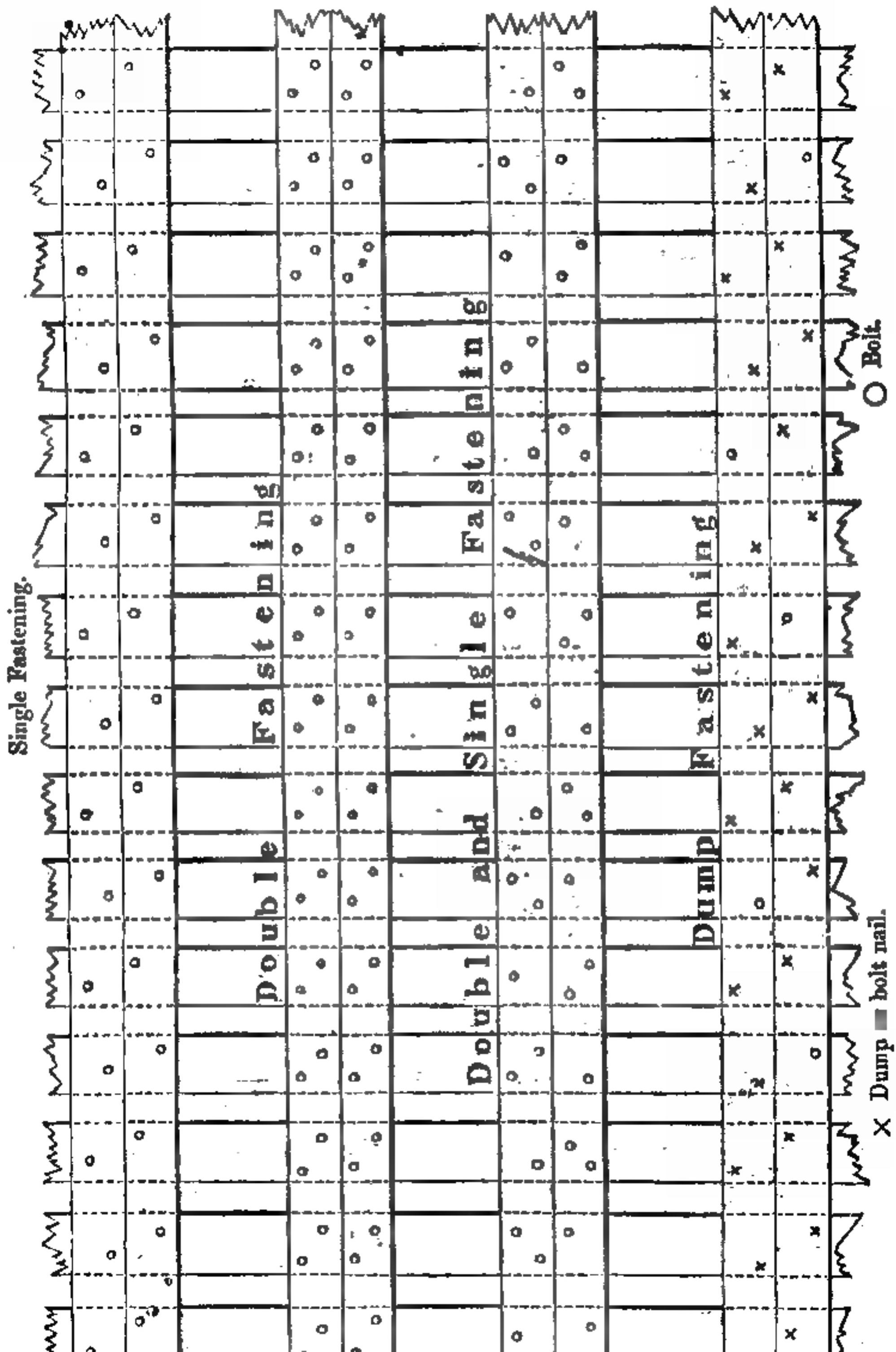
In working the plank of the bottom, including the wales and thickstuff, the earnest endeavour of the practical naval architect should be, for the plank to be brought to the timbers without having recourse to forcing the plank upwards to the edge of that already worked, or that which, in mechanical phraseology, is called an edge set, should be used as little as possible.

that would bear the bending one way, may be easily broken by ■ attempt to force it the ■ way to that already used; and in working the plank, should the edges or the thickness of the plank be bruised, and the bruised portions of them not be removed, early decay of the plank will ensue from the injury which has been received by the grain of the wood. The best method to obtain the desirable end—that the plank should be worked to the bottom of the vessel without being crippled by edge sets, and to meet the circumstance of the girt of the midship body of the ship being so much greater, from the form given to the vessel, than those of the fore and after bodies—is, to pen or bend ■ broad batten round the timbers of the frame, in a longitudinal direction, ■ ■ representative of the plank, at the breadth in midships, of every six ■ eight strakes of plank, allowing the ends of the batten to take their own position on the timbers of the frame. This arrangement will give spaces fore and aft, considerably less than those set off and determined on amidships, as the space to be occupied by the six or eight strakes of planks, which decrease of room for the reception of the planks must be met by the fore and after shifts ■ lengths of plank being diminished in their width gradually, all fore and aft of their lengths; and should it be necessary, some of the shifts at the extreme ends are dispensed with, by the use of what is in ship's carpentry denominated ■ stealer (see Plate of Expansion of Plank). The diminution of the width of the planks at the bows and quarters assists the conversion of the plank, ■ it allows of plank being used, that, from having sap or unformed wood on its edges, would be unavailable for the breadth used for the midship portion of the plank of the bottom *.

The fore and after ends of the fore and after shifts of each strake of thickstuff and plank are reduced in thickness, that they may be brought round the curved extremes of the ship with less labour, and likewise lessen the depth of the rabbet in the stern or stern post. As a general rule, the

The plank should be well seasoned before worked, and to ensure as far as possible the durability of the ship, which would be seriously affected by the materials used in her being green, — having been provided from timber or trees lately cut down, it is highly advisable, after the plank has been hung to the frame timbers by Mr. Blake's screws, that the holes, for all fastenings that can be determined, should be bored off and left open to the draught of air that will be then drawn through them, and thus furnish the means for the internal juices of the timbers to be drawn off, and the timbers to be well seasoned.

The planking in former times was fastened to the timbers of the frame by long wooden pegs, called treenails, the practice being in large ships to place in each timber, through the planking, two of such treenails ; this was technically denoted double fastening. This mode was found to weaken the timbers by what has been justly termed their being riddled or made full of holes, and this led to the system called double and single, or two treenails being placed through the one timber, while each consecutive timber had but one in it. Treenail fastening — nearly exploded from the British navy between the years 1834 to 1848, from the decay that was said to be attendant on the use of the treenail ; and from the treenail being subject to be broken or upset by injudicious caulking of the seams, and thence copper bolts combined with a short mixed metal bolt-nail were introduced. The greatest evils attached to this system, are the additional weight thus given to the hull by the copper and metal, which — eight times heavier than the wood bored out for their reception ; and that the metal bolt-nail has no hold in the timbers, and moreover, if not driven with judgment, has — great tendency to split the plank and cause leaks. The treenails have, under these circumstances, been again resorted to by many practical men, — yielding good fastening with lightness of hull.


BUILDING


The upper strakes of the planking, or those above the water, are sometimes connected to the frame of the ship by the arrangement shown in the sketch below, and the tie thus given to the frame of the vessel and the planking is undoubtedly a good one.

b the butts of the outside planks ; *a*, dowels placed in the timbers immediately adjacent to the butts, and in the planks above and below the butt, or end of the plank, the butt itself being $\frac{1}{3}$ rd and $\frac{2}{3}$ rds on the timber to ensure wood for the reception of the butt-bolt in the $\frac{1}{3}$ rd wood, while the $\frac{1}{3}$ rd wood of the timber forms a good stop for the caulking, the other butt-bolt being placed in the adjacent timber of the frame.

Positions of the wales, diminishing planks, and the outside and inside planking are shown in the Plate (2).



PART X.

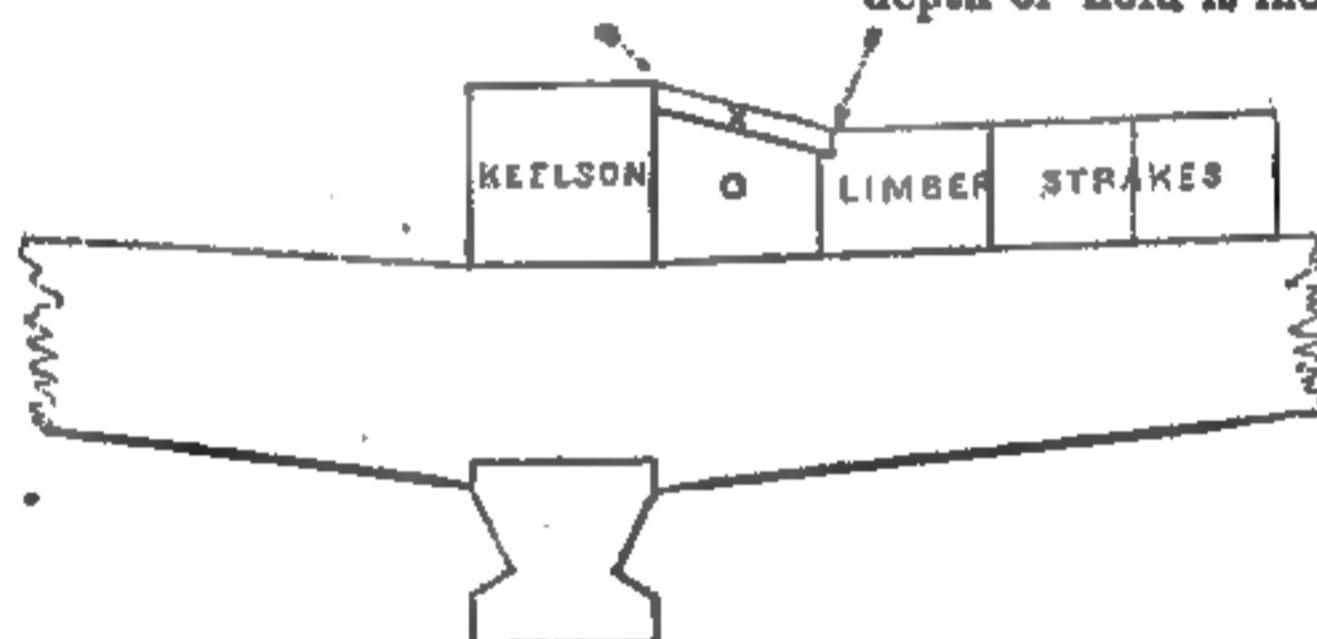
Inside Plank.—Description of the Limber Strakes, Strakes over the Heads and Heels of the Frames of the Ship.—Beams of the Ship considered as being connected with the Shelf and Waterway, when the two latter are viewed as portions of the internal Planking.—Reference to the Clamps and Spirketting.—Trussing between the Ports.

INSIDE PLANKING.

THE first band of plank from the keelson is called the limber strakes ; space being left between the side of the keelson and the lower edge of these strakes, to form, if it were, a gutter for the passage of the water arising from leakage or other causes to the pumps or pump-well. A rabbet is taken out of the lower of these strakes, of which, in a large

boards or limber plates: the intention of these boards or plates is, by their forming a covering to the limbers, to keep the dirt, which unavoidably may fall into the hold in stowing the ship, out of the gutter or limbers, that it may not be drawn into the pump-well and choke the pumps; the limber plates, so-called, when formed of iron, possess the additional advantage of forming a portion of the required ballast, thence giving room for cargo or stores. The depth of hold, a standard dimension of the ship, is measured from the midship edge of the lower strake of the limbers.

Point from which the dimension of the ship termed the depth of hold is measured,



O Limber or watercourse.

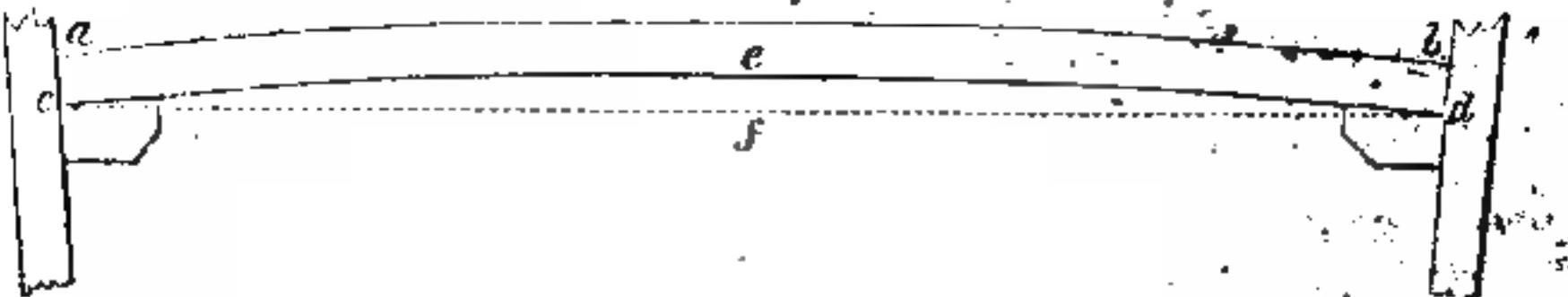
X Limber board or plate.

The planks worked internally, next to these, are those over the respective heads and heels of the frames; the heads and heels are marked in Plate 2, F H, I H, &c., and the planks F; and the same system should be adopted as was suggested for the working of the outside planking—that of pitching or placing them immediately over the joints of the frame amidships, and allowing the extremes to follow the directions that will admit of their being brought to the timbers without an edge set. The number of strakes over each line of heads and heels varies from two to four in midships, according to the size of the ship, and they are invariably reduced in number and thickness at the extremes or fore and after parts of the vessel, the decrease in the

strakes it is the practice of some builders to work short lengths of plank placed diagonally, while others leave the space open; the expense incurred by filling in between these thick strakes is not repaid by commensurate strength to the ship, and increasing the number of surfaces of wood, in contact with each other, is forming so many additional causes for early decay of the ship, which should be well considered by the practical builder before he loads the hull of the ship with unnecessary wood and its consequent fastenings.

BEAMS.

The beams are placed across the ship, and in one respect may be considered as being to the ship what the rafters are to the house, the foundation to receive the floors or decks of each; but the beams of a ship are no tie to the walls or sides of her; the beams in her do not keep the sides from falling outwards or spreading; on the contrary, the direct tendency of the beams, when weights such as the guns of a man-of-war are placed on the platform or deck, which the beams support, is to bring a very considerable thrust or push on the sides of the ship to force them outwards. This is observed in practice by the falling of the beams on the quarters, or the midway between the middle line of the ship and each of her sides, and none can gainsay the fact. It would not be well, in this rudimentary work, to enter into a scientific detail of the cause of this palpable effect; but an elucidation of it may perhaps be afforded by the following simple statement:—the beams, which are placed across the ship, are set to ■ round or portion of ■ large circle, that the decks, from being laid upon them, and necessarily partaking of that round, may throw the water that may be used on them when the ship is upright, into the side, where holes, technically called scuppers, are placed to admit the water to the interior of the ship.



The beam *a b c d* resting on the shelf on either side may be looked upon ■ an arch having for its abutments the sides of the ship at *a c* and *b d*; the weights placed on the upper side of the beam, or such an arch *a b*, would tend to force it, having a round or pitch, *e f*, into a straight line (as *c d*), and nearly the whole strength of the arch depends upon the abutments *a c* and *b d*; for if they be immovable, the arch can only be destroyed by the destruction of the materials of which it is composed. In the ship the abutments formed by *a c* and *b d* are unsupported, and have no stablyness in themselves, and the beams are only supported at the middle by pillars; and the results are, that on the guns or other weights being placed on the decks between the points *c* and *e*, or *d* and *e*, or on what are in nautical terms called the quarters of the beams, the round *c e* or *e d* drops into the straight lines *c f* or *d f*, by the horizontal thrust of the beam forcing out the side of the ship at *c* and *d*. This must cause a weakness in the structure, which may be obviated in some measure by the under sides of the beams being made straight. The round of the decks might still be produced for the recoil of the guns and carrying off the water from the decks. The beams of small vessels admit of being provided from one piece of timber, or of being in one length; but in larger ships, their scantling, or width and depth, called in mechanical parlance siding and moulding, coupled with the lengths required, will not admit of their conversion being made in one. They are therefore composed of two or three pieces, according to the store of timber, and are scarphed together by side scarphs. The usual method in the Queen's service is to employ coaks or dowels with bolts for the security of these scarphs, ■ shown in the sketch, the length of the scarph being $\frac{1}{3}$ th the length of the beam (see Fig. 1, Plate 4).

The moulded way, or depth of the beam, is less than the sided way, which is the weakest form to be given to the same area of section, strength increasing with depth; but the siding being greater gives under the ■■■ quantity of wood a greater surface for the deck to rest upon. Mr. Edye, the master shipwright of Plymouth Yard, has introduced in these latter days a scarph for beams, which had its foundation in the key scarph of old date, used by the joiner or house carpenter, as also the scarph used by the shipwright to join the harpins; it is formed as shown, Fig. 3, Plate 4.

This scarph does not find many proselytes; and it is the firm conviction of the writer of this work, that, for strength and ease of workmanship, it will be found in practice inferior to the method of scarphing where dowels are used.

WATERWAYS.

The shelf which is worked to receive the beams-ends of the several decks may also be considered as ■■■ internal hoop placed under the beams to increase the rigidity of the frame of the ship; and the waterway which is now to be described forms a similar tie on the upper side of them. The butts or ends of them, which are made unavoidable by the limits of conversion of the timber, are not scarphed or overlapped with each other as in the case of the shelf; consistency would make the practical builder forego that arrangement in the shelf, if he considers that the waterway is efficiently united without them. They are placed upon ■■■ carling between the beams; and on the decks having ports, the butts of the waterway should be under the port, to give more latitude for the butts of the spirketting, which should give good shift to the ports. The butts of the waterway and shelf partake of the same arrangement as the butts of the outside and inside planking; and there is no apparent and sufficient mechanical reason why the difficulty of conversion which attends the scarphing of the shelf, if repaid by additional strength, should not be extended to the other por-

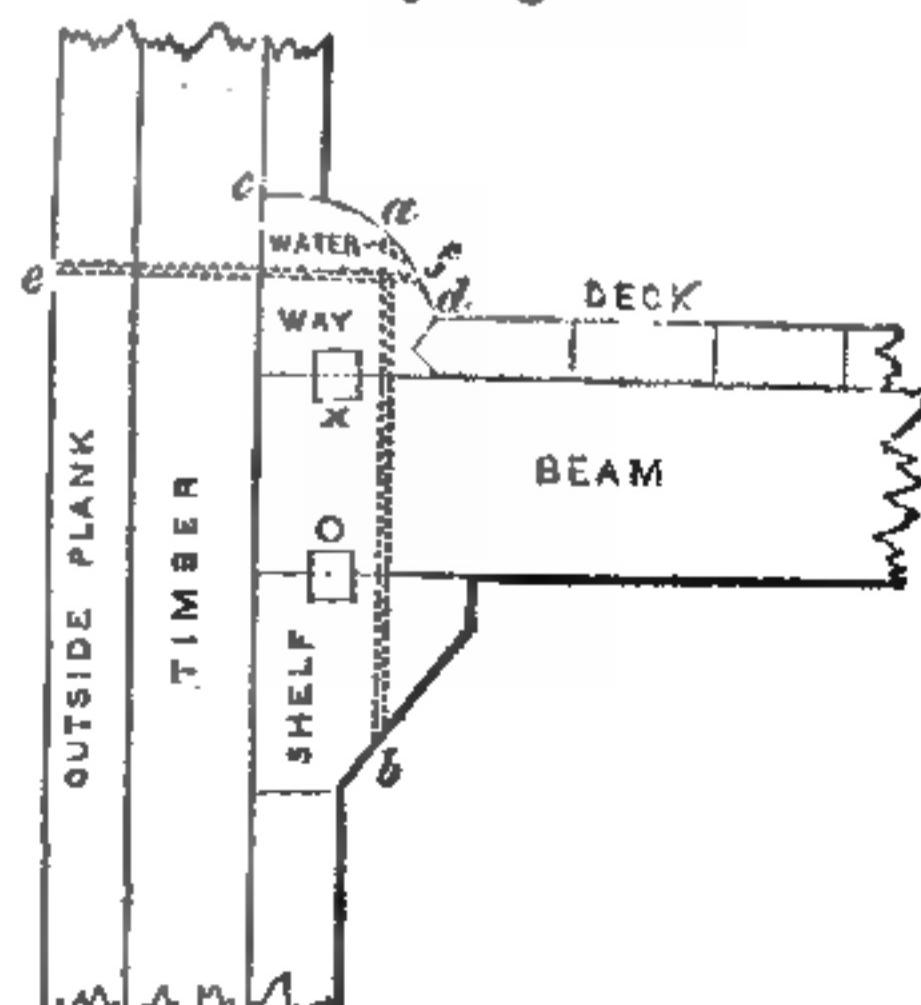
plank of the bottom. But, on the other hand, reflection should cause the practical builder to consider all the parts of a ship as being made to succour each other, and thence not seek to complete each portion as perfect in strength of itself; and if he came to that just conclusion, the shelf would in common with other plank be worked with square butts. The waterways have been subjected to many alterations in shape and in their mode of connection with the beams. Good theoretical arrangements have been adopted to unite them firmly with the beam-ends; but these unions have depended so much on good workmanship, which could not be ensured, by even the most careful workman, from its being hidden from his view, that they would thence not be perfect even if no shrinkage took place in the wood—results that practice has proved to be beyond the skill of man and out of the course of nature. These remarks bear reference to the method of dovetailing the waterways and beam-ends, or that of letting down the waterways over the ends of the beams with a score or hole wider at the inner edge of the under surface of the waterway than at the outer edge. The most effectual way to tie the beam-end to the waterway is to dowel the two together and bolt the shelf, beam-end, and waterway together.

× Dowel in waterway and beam.

○ Dowel in shelf and beam.

a b Bolt through waterway, beam,
and shelf.

e f Bolt in and out through water-
way, timbers, and outside
plank.

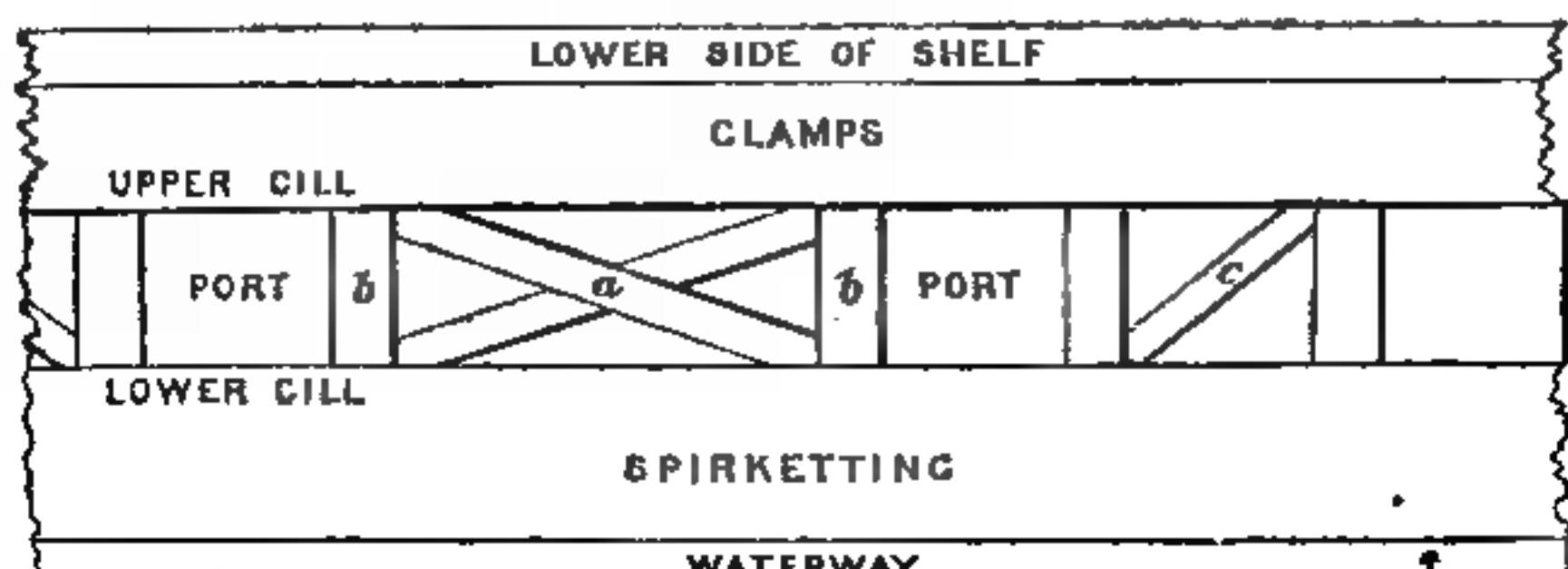
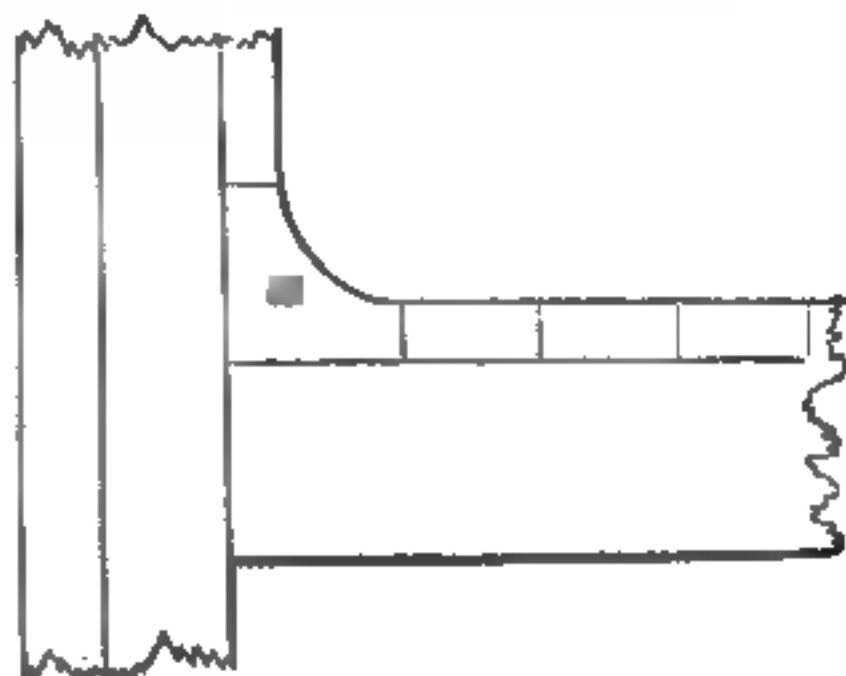


On the decks intended for the reception of guns, the water-

the training of the guns, and thence the round part (*c d*), which interfered with the training or pointing of the guns, underwent a change by being hollowed out to admit of the truck or wheel of the gun-carriage being worked into it.

a is a section of the waterway, with the necessary alteration for the efficiency of the gun in men-of-war. In the merchant service, except in the larger vessels, thick waterways are not used.

The inside planking immediately under the shelf of each deck is called the Clamps; while that placed over the waterways is distinguished by the technical term of Spirketting. As a more effectual preventive to the beam-ends rising off the shelf pieces, from any alteration in the angle made by the beam with the side of the ship (p. 49), when the vessel is rolling in a sea-way, the spirketting should be dowelled to the timbers of the frame, a practical arrangement that cannot fail to succour the waterways which form the upper abutment or resistance to any movement of the beam-ends; and in men-of-war the clamps work down to form part of the upper cill of the port; while the spirketting works up to form a portion of the lower cill of the same: both clamps and spirketting are usually bolted edgeways.



The space between the clamps and spirketting is shut in

ports. In Sir Robert Seppings' system of ship building, in this portion of the ship the short stuff was worked up as a truss-frame, abutment pieces being worked at the sides of the ports — shown by the preceding Fig., and Plate 3.

b are the abutment pieces, and — the truss, the section showing the direction given to the trusses placed between the ports before the middle of the ship, the truss being reversed in position in the spaces between the after ports as shown by *c* of the Fig.: these trusses were — short that little advantage was found to attend on their use, and the expense of their practical carpentry has caused their disuse.

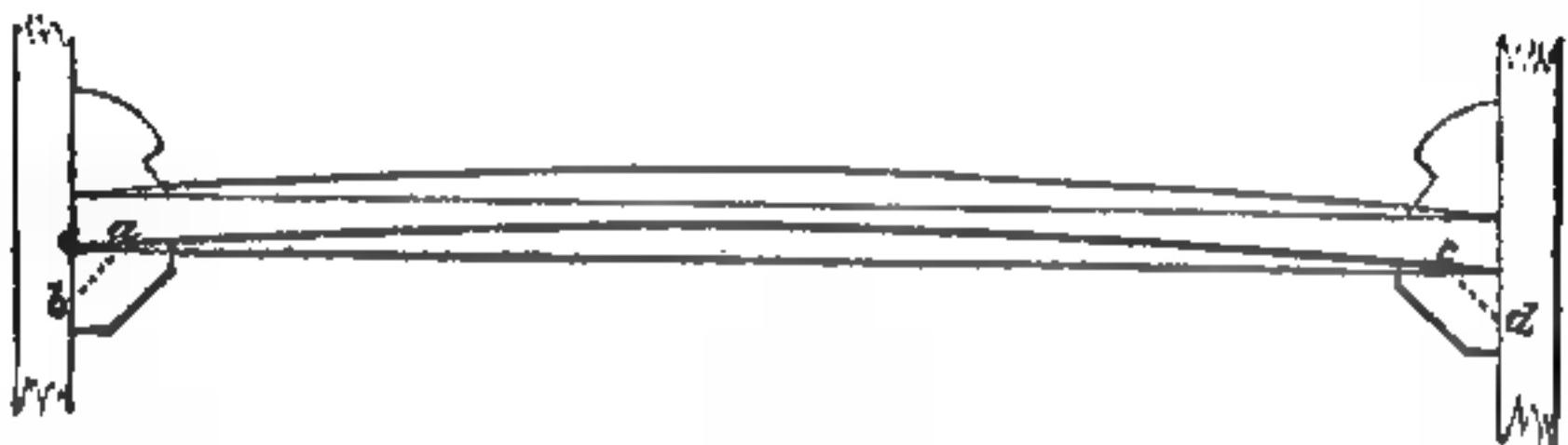
PART XI.

Description of the action brought — the ends of the Beams of a Ship when rolling in a Sea.—Methods by which the ill effects of such racking or straining has been partially counteracted.—Breast-hooks and Crutches described, — formed of Iron.—Wood and Iron, or wholly Wood.—Transoms, their use.

SECURITY OF THE BEAMS TO THE SIDE OF THE SHIP.

A SHORT outline has been given descriptive of the beam of a ship, as being first placed on the shelf, followed by the water-way being worked above it, and then the process of uniting together the waterway, beam, and shelf; the connection of these three en masse with the frame of the ship has also been briefly pointed out, supposing the beam-ends to have no other security than these ribs of thick planks. Sufficient in strength — such a combination might prove for vessels built for commerce, it would be found wholly inadequate to the rack which is brought on the decks of a man-of-war, loaded with heavy guns, when the ship is acted on by a heavy sea, and she is propelled by such a large moving power as the sails of a vessel of war. Many have been the expedients that have been adopted to prevent the working of the beam-ends from the sides of the ship: but before any of

and familiar point of view, the ■■■■■ which produce the injurious effects which it has been the aim of all practical ship-builders to diminish in part, or, if possible, totally to counteract.



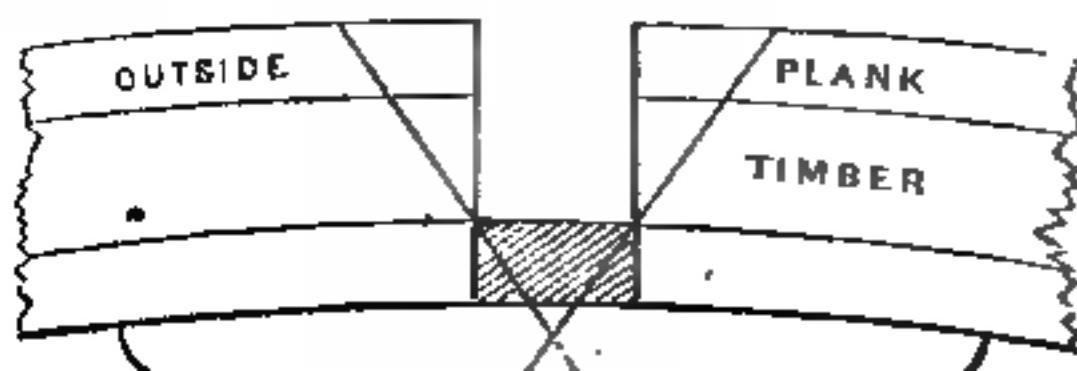
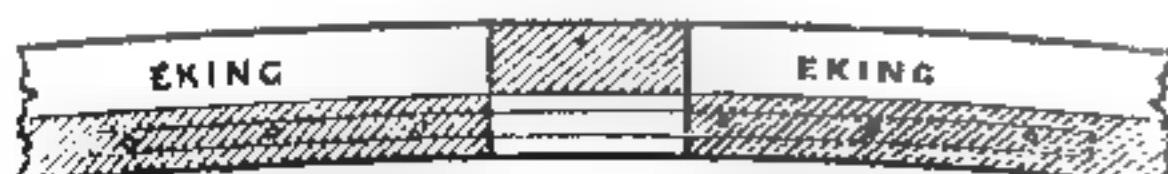
The rolling motion of the ship has been found in practice to alter the position of the beam-ends with respect to the sides of the ship, or that there is ■ variation in the spaces marked *a b* and *c d*, or the ■■■■■ of the angles that the beams make with the timbers. The effect which is produced may be thus considered: suppose *c d* to be on the lee-side or side immersed, and *a b* to be on the weather-side, or the side that is raised out of the water in the rolling motion, there will be a strong tendency to increase the length of the line *c d* by the beam being raised from the shelf; while, on the contrary, there will be a similar effort to decrease the line *a b* by the force produced pressing down on the shelf. To resist these strains, and preserve the fastenings of the ship from being racked when subjected to them, should be the earnest endeavour of the practical naval architect. That these effects shall be wholly neutralized is beyond the skill of the shipbuilder, while the sides of ■ ship are left without support ■ described when the beams were under consideration. Several methods, or sketches of knees, will now be given by which this desirable end has in some measure been accomplished (*vide* references to Plates ■ and 7).

BREAST-HOOKS AND CRUTCHES.

To unite the two sides of the ship together at the fore and after extremes, or at the head and stern of the ship, in the

the keel, inside timbers are worked ; those forward are called breast-hooks, and the after ■■■ crutches. These hooks and crutches have equal arms extending across the middle line of the ship, at which place, or at their throating, they are the widest, or of the most moulding. The lengths given to the ■■■ of these hooks is determined by the store of timber, and the number of them is at the discretion of the practical builder; they are equally spaced between the deck-hooks, which latter may be very well included under the same head with them, with this distinction, that while breast-hooks are placed square to the stem and the form of the bows, by which position they cross several timbers of the frame and tie them together, the deck-hooks must have their upper surfaces to lay with the round up of the beam, and to the sheer of the deck, and that their positions are fixed, from being at the heights of the several decks.

The difficulty which attends on the conversion of timber into breast-hooks, deck-hooks, and crutches, has led to their being in some instances made wholly of iron ; in others of ■ combination of wood and iron ; and yet again of wood, under an assemblage of parts or pieces. When wholly of iron they are strapped over the apron, ■■■ shown in the sketch here given.



Wood in combination.

When composed of wood and iron, two arms of wood, called in the trade ekings, are worked, the upper surface of them being flush with the upper side of the apron, and on the upper side of these an iron breast-hook or plate of iron is placed and bolted through the frame-timbers and planks. When formed of wood, two ekings are worked, ■ pointed out in the combination of wood and iron, and then ■ wood hook over them, the whole being bolted to the ship's bottom.

The size of the bolts used in these ties for connecting the sides of the ship at the fore and after boundaries of her, vary in size, even in the same hook or crutch, the bolts in the throating or the widest part, being larger in diameter than those placed at the ends; and the bolts at the throat should be placed across each, ■ shown in the sketch, for wood breast-hooks, to bring the fastening square to the outside plank for efficiency, and to shorten the bolts for economy and lightness. The bolts should also be spaced on the upper and lower edges of the depths of these hooks; such depths being in the deck-hooks usually the moulding of the beams of the respective decks. (*Vide* also Plate 5.)

The foundations used to receive the ends of the several decks abaft, and to unite the stern to the body of the ship, are called deck transoms; they are worked in ■ similar method to those described as deck-hooks for the fore part of the ship. In ships with square sterns ■ transom called the wing transom forms the base of the stern.

PART XII.

Framing the Decks or Platforms.—Mast-partners as fitted in the British Navy.—As fitted in the French Navy.—Framing to Hatchways and Ladderways.—Riding Bits, their ■■■ and position.—Admiral Elliot's Bits, where used.—Flat of the Deck.—Inner Waterways.—In large Vessels, how secured.—Ports.—Size, how determined.—Elevation and depression of the Guns.—Distances between the Ports.—Limits to such.—Descriptions of the Port Lids.—Half Ports and Bucklars.

FRAMING OF ■■■ DECKS.

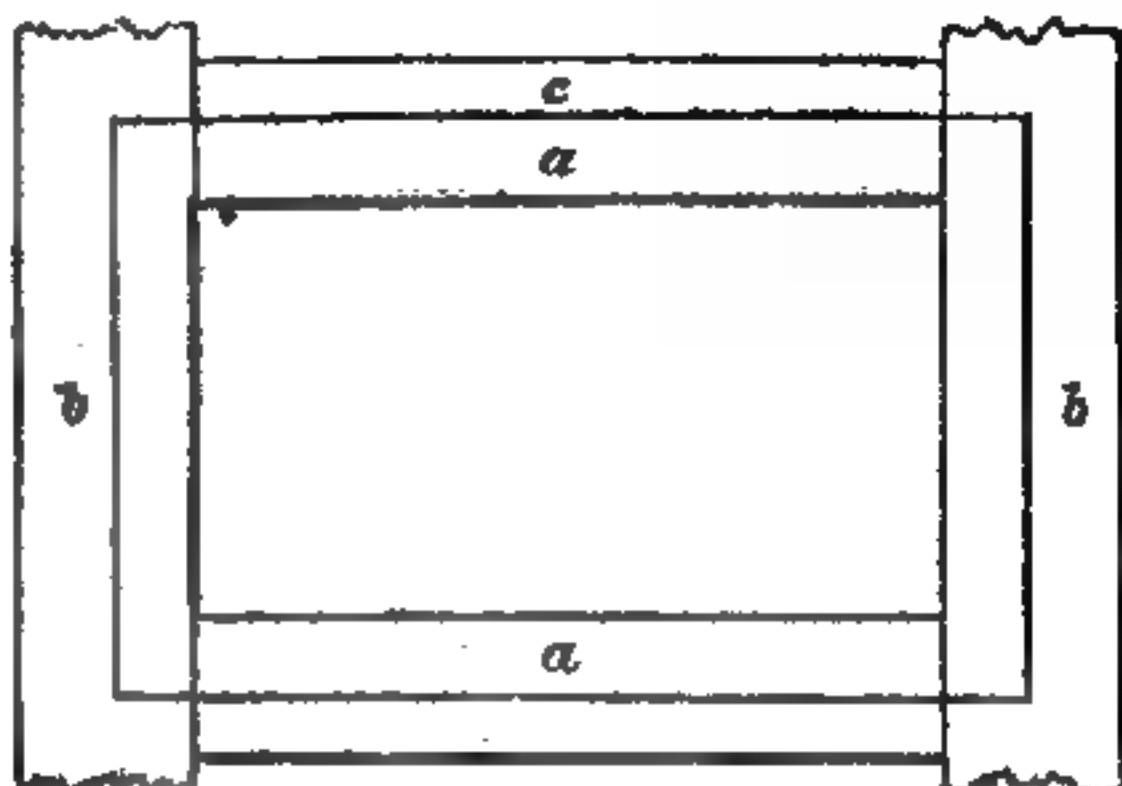
THE beams of the deck having been placed across the ship, on the shelf, and the knees worked to them, with the waterways over them, the next work to be performed becomes what is technically termed the framing of the deck, or what would be called by the uninitiated the mocking out the doorways and trap-hatches. Of these, the first in consideration is the provision to be made for the security of the masts, called mast-holes. The mast-holes are larger in diameter than the respective masts at their several heights, by double of the thickness of the wedge which is considered to be sufficient for keeping the masts in position ; these wedges vary in thickness from ■■■ inches to ■■■ inches, according to the size of the vessel.

The framing for a mast-hole, where deck wedges are used, is composed of fore and aft partners, cross partners, and corner chocks. The French have usually the cross partners of the foremast on the several decks shifting or movable ; thus providing for an alteration in the position of the foremast without much expense being incurred ; the fore-step, ■■■ where the heel of the foremast is supported, being ■■■ framed ■■■ to admit, within certain limits, of ■■■ corresponding movement.

The hatchways, or doorways from one deck to the other, are formed of four pieces ; the two placed fore and aft are technically called coamings, while those athwartship ■■■ denominated head ledges. The head ledges rest on the beams,

and the coamings have pieces of wood called carlings placed under them, reaching from beam to beam.

PLAN.

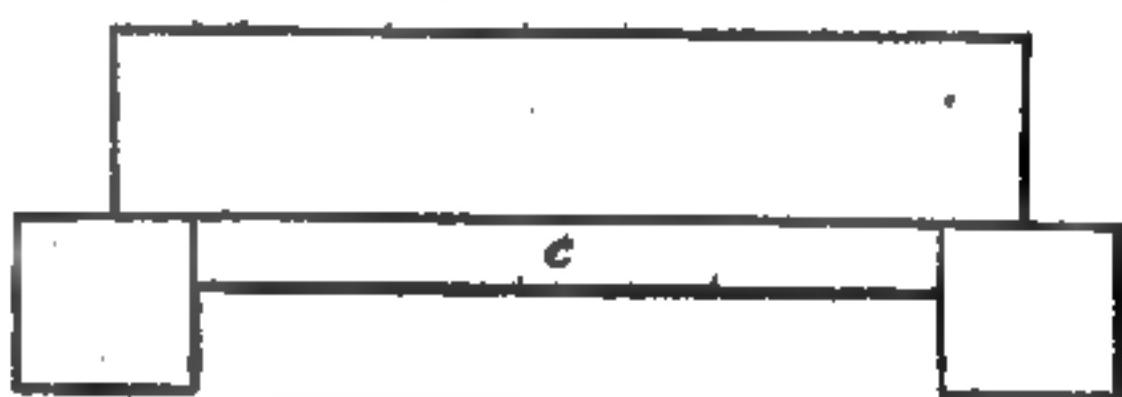


a a Coamings.

b b Head ledges.

c Carling under coaming.

ELEVATION.



The carling (*c*) is worked 2 inches wider than the coaming, to form a support to the strake of deck-flat that comes over it. The head ledges and comings are dowelled and bolted to the beams and carlings. Their height above the beam is such as will prevent the sea, if it should be shipped or taken on board, from rushing into the hold of the ship. The coamings have a rabbet or groove taken out of them to receive gratings that are placed over the hatchways, to give a free passage across them in time of action.

The ladder ways are framed in a similar manner, and on the deck exposed to the weather there are skylights and framings for the galley or cooking range worked on a similar system; but these minor points can only be alluded to, in a rudimentary work of this size.

RIDING BITTS.

ON SHIP BUILDING.

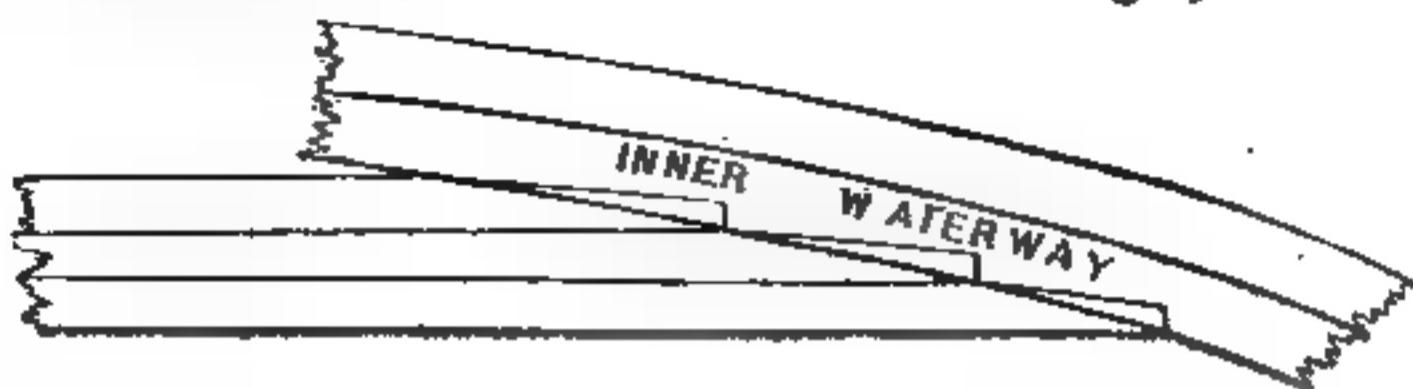
vessel is riding by her anchor, or held from movement by the anchor, and are thence called riding bitts. In H. M. Navy, from the line-of-battle ship down to the small frigate, there ■ four riding bitts ; or, ■ it is usually termed, there ■ two pairs of riding bitts, such bitts being on the deck immediately above the water, ■ the lower deck of the line of battle ships and the upper deck of the frigate. The brigs and flush deck vessels have only one pair of riding bitts.

The bitts run through two decks (see sketch, showing plan and fittings of riding bitts), and ■ succoured by ■ standard secured to them by bolts, dowels, &c., ■ shown ; the cross piece completes the holdfast for the cables. Sometimes, where the deck is confined in space for the working of the guns, the arming of the bitts and the form of the standards to them are worked on a plan suggested by Admiral Elliott. This method of securing the bitts for the reception of the cable should never be resorted to but when want of breadth in the vessel compels its use, the bitt-heads on this principle having been known to be twisted out of place by the force of the cable when being worked round them. A sketch of them is added. In the merchant service the windlass is made to answer for riding bitts, doing the double duty of a capstan and riding bitts. A description of the windlass will be given when the capstan is under consideration.

FLAT OF DECK.

Next to the waterway, at the side (Fig. 2), as before described, ■ plank 1 inch ■ in thickness than the intended thickness of the platform or deck is worked with one edge into ■ rabbet formed in the main waterway for its reception ; this is called the thin waterway, the inner edge being reduced to the thickness of the deck plank ; the use of the thin waterway is to receive the ends of the decks forward and aft, as shown by the sketch in p. 60. In large ships the inner water-

the caulking of the seam of the thick waterway. Thickness of deck (Plate 2). (*Vide* Scheme of Scantlings.)



PORTS.

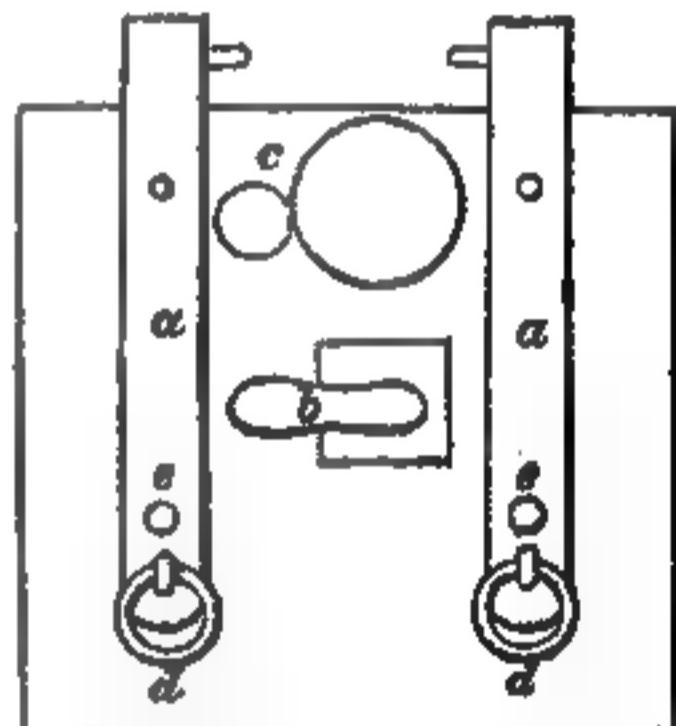
In ■ man-of-war, or a vessel intended for war purposes, the sides above the water are perforated with oblong holes denominated ports, in which the guns are worked ■ manœuvred, and out of which they are fired. The size of these ports or apertures is determined by the calibre of the gun that is to be used in them, and the height of the lower part of the port, or the upper side of the lower port-cill from the deck, is fixed by the height the naval artillerist gives to the centre of metal of the gun, or the middle line of the gun when it is set horizontal or point blank, when combined with the requisite depression, or that which will allow of the gun being pointed downwards to the extent considered necessary to make it efficient; after which, the depth of the ports on the several decks, or the up and down dimensions of them, is regulated by the required elevation of the muzzle of the gun above the point blank position of it. The depression and elevation considered effective in the Royal Navy of England is 7° of depression, and 9° of elevation, the quadrant being 90 of such degrees, or that portion of ■ circle which denotes a range of angle from the horizontal or level portion to that of the perpendicular, or what is ■ familiarly termed plumb. The ports ■ from 7 feet ■ inches to 9 feet apart, according to the views of the constructor, who should in this particular give the utmost range of which the proposed design will admit, as crowded quarters ■ small spaces between the guns lead to confusion in action, and possibly to casualties which if ■ longer and more open platform had been allowed would

fixed by the desirable end that the principal dimensions of the ship should be the least possible that will carry with efficiency the armament which it has been determined she shall have on board. (*Vide* description of the Plate to Ports and Guns).

PORt LIDS.

The apertures through the sides for using the guns, or the ports, are closed up in tempestuous weather by the port lids, which are the lower decks of the large vessels of the English navy, or ships with two armed decks and upwards, are made to close the port-hole in one piece, and they are hung with hinges on the upper side, which, with the method of fitting them, is described in the drawing annexed

- a Port hinges of iron.
- c Illuminator for light when the port lids are down.
- b Scuttle in the port, to allow of the —— for loading the gun to be out in bad weather.
- d Ring bolts to receive the port pendants, —— rope —— chain to raise —— port lids.
- e e Rings. Bolts on the inside of the port to bar them in by.



Air scuttles, invented by Mr. Lang, of Woolwich Yard, are now fitted between the ports, in lieu of the illuminator (c).

On the upper deck of line-of-battle ships, and main-deck of frigates, the ports are in two parts; the lower part hung with hinges on the lower part of it, called a bucklar, and the upper part a half port to put in by hand.

PART XIII.

The Internal Space of the Ship ; how apportioned when fitted as a two-decked Ship of War, and appropriated to the usages of the British Navy, arranged under the several heads of—Hold ; Orlop ; Lower — Gun Deck ; Main — Upper Deck ; Quarter Deck, Waist, and Forecastle ; Without Board ; including a few cursory remarks on the Fittings required for the Sailing Evolutions of the Ship.

THE numerous fittings of a man-of-war will next be given, although much of the finish of the hull of the vessel has necessarily been omitted, from the restricted space afforded in this rudimentary volume for the details of such a vast and complicated structure as a first-rate man-of-war. The prominent features of the vessel have been briefly described ; if even such, had been attempted for the minutiae of it, this small volume would in bulk have greatly exceeded its limits.

The inside of the ship having been apportioned into divisions or floors by means of the several decks or platforms, these again are subdivided each within themselves, and appropriated respectively to the accommodation of the officers and men, to the stowage and keeping of the water, powder for the use of the great guns and small arms, and provisions for the ship's company, and the stores requisite for service at sea. This internal arrangement admits of much controversy, and rival constructors and most naval commanders have their own opinions on the most advantageous position for the weights the ship has to receive on board. In this elementary work, an opinion of the merit or demerit of particular plans for stowage ought to have no place ; but it may be considered within its limits if the hint is advanced, that in disposing of the several portions of the floors or decks, due regard should be paid to the use to which it is intended to apply them. As an instance, in the main hold, or store-room for water, care should be observed that the bulk heads, or what may be considered

certain number of iron tanks for holding the water; the tanks denominated 2-ton tanks ■ in length from out to out 4 ft. 1 $\frac{1}{2}$ inch; the hold should thence be in length ■ multiple of 4 feet 1 $\frac{1}{2}$ inch, so ■ to take in four, five, or six, &c., lengths of tanks, and have no broken stowage. The same rule should be observed in the provision rooms that are stowed with casks, and the naval constructor will be more likely to succeed in his design when ■ system is pursued by him in such ■■■■■

HOLD.

The hold is the internal lower part of the shell or hull, and is wholly taken up as a deposit for provisions, water, and stores. The divisions of it in a man-of-war may be classed as follows; premising that the bulk heads by which the compartments are formed are made of 3-inch plank, sometimes worked up and down, at other times athwartships with stantions; but in both instances coming to a beam. Commencing then from forward, the store rooms of the gunner, boatswain, and carpenter, or warrant officers, are placed; within which are the sides of the fore magazine or powder store, and its light or room to receive lamps to light the magazine. Next aft to these is a coal-hole, then the fore and main holds for the water tanks, inclosing the pump well or space for the reception of the pumps, and lockers or boxes for chain cables and shot, which are thence centred round the main or principal mast; such being the position given to them to concentrate the weights for the easy motion of the ship in pitching against a head sea. The after hold next follows, in which is placed what are technically called the wet provisions, or beef and pork in brine, inclosed in casks; the portion of the hold next to this receives the dry provisions, namely, oatmeal, peas, cocoa, &c.; while aft again of it is the spirit room, or store for the rum and wine for the ship's company, and then there is usually a coal-hole, inclosing the after magazine or store of powder for the guns at the after part of the ship: and the extreme

reserved for the bread room, in which the biscuit is stored in bags containing 2 cwt. each, and occupying ■ space of at least 5 cubic feet each bag. In latter days, to form some protection to the powder magazines from shells, when fired by an enemy in action, water in tanks is placed round the sides of them.

ORLOP.

Leaving the hold and coming on to the orlop of ■ line-of-battle ship, there are, forward, the upper store-rooms of the gunner, boatswain, and carpenter,—and next aft to them, the cabins allotted to those officers as living and sleeping places. Other cabins are to be found in this part of the ship, coming on the same range, for the junior marine officer and pilot, &c. The cable tiers or store-rooms for the hempen cables follow, one on each side; the centre part between them being occupied by the sail-room, which extends from fore hatch to main batchway, a position which facilitates the stowing or removing of the sails. There is ■ clear passage kept round the ship, which is called the wings, and is strictly preserved ■ such, to enable the carpenters of the ship in action to have easy access to the sides of the vessel to plug up the holes made by the shot of the enemy between wind and water, or at the surface of the sea, which holes would otherwise endanger the safety of the ship.

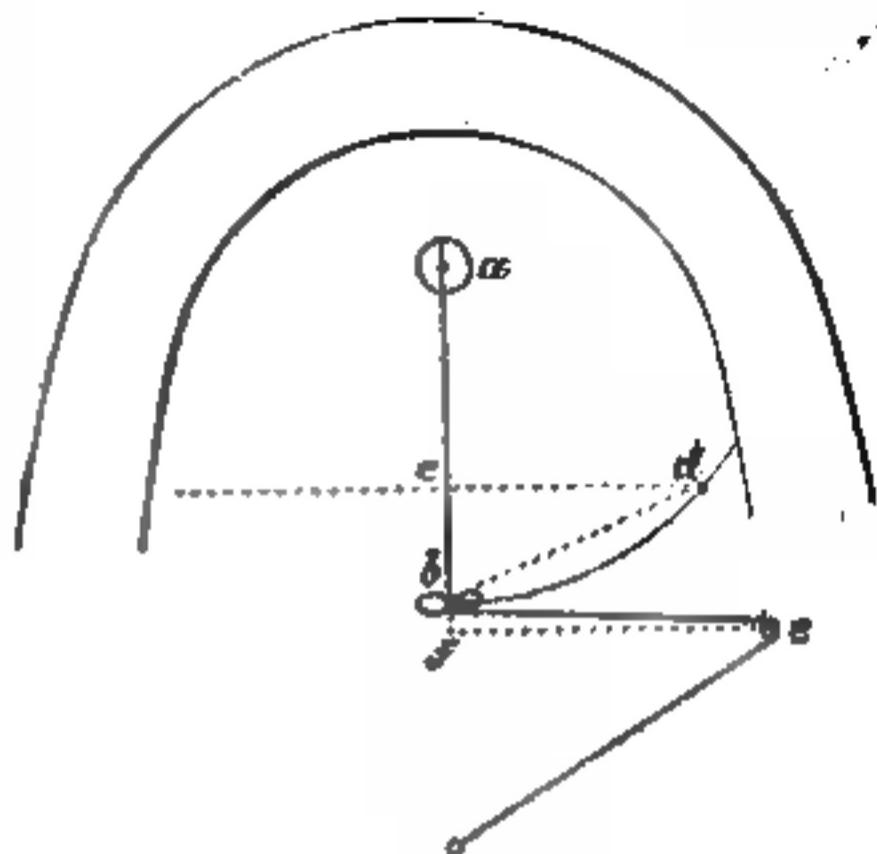
Aft of the main mast on this deck, on each side of the ship, are cabins for the officers, and store rooms for the reception of their private stock of wine, &c.; the centre part between them, which is fitted up with ■ amputation table, for the use of the surgeon in time of action, is called the cockpit; in this portion of the ship the midshipmen sleep in hammocks slung up, similar to those used by the seamen.

LOWER ■ ■ DECK,

The platform on which the heaviest guns to be carried in

pages be briefly alluded to, armed with very heavy guns, and those possessing a long range, has caused the introduction of guns of similar metal on to the weather or highest decks of the sailing ships of the line, to render them more efficient. The guns in the sailing vessels or ships of the line being on the poop and forecastle, it places them considerably above those on the deck of the steam vessel, and necessarily gives them ■ greater and more effectual range. On this deck ■ the riding bitts (*vide* Plate of them), by ■■■■■ of which the hempen or chain cables to the anchor or anchors ■■■ attached and secured to the vessel, for riding the ship when required. At the after part of it the tillar, or governor of the movements of the vast fabric, is placed, inserted into the head of the rudder; the ropes by which the required positions of the tillar are effected being led by blocks to the steering wheel, which is placed on the quarter deck. The effective and easy direction of the intended course or road of so large a body as the first-rate man-of-war, has in all times taxed the ingenuity of the shipwright and mechanic; and thence plans have been patented and partially adopted which, in a few months, or at the most ■ few years, have been condemned by practice. The following method of fixing the blocks for steering a ship has been found to ensure steadiness of motion in the rudder, to prevent any sudden jerk on the wheel, and to enable the helmsman to reverse the position of the rudder immediately it is required. Assuming that the tillar is to be moved by the double rope ■ each side of it, passing through blocks at the end of it, the quantity of rope required under the usual fitting to string it is the most when the tillar or helm is amidships, whence any movement from the middle position of it will give ■ slackness to the tillar rope on the ■■■ side, and allow of the force of the waves, when striking the rudder, to jerk the wheel; but there ■■■ positions for the fixed points and blocks, which have been determined by the aid of mathe-

Description of the diagram of a tillar thus fitted—a section of the head of the rudder; *a* being the centre of it and centre line of the pintles. *b* position of the blocks at the end of the tillar, to receive the ropes, the tillar *ab* being amidships, or being in the fore and aft direction of the ship. Divide the distance *ab* into three equal portions, of which *bc* is one, having previously swept the tillar down to describe the circle developed by the end of it. The point *c*, squared athwart the ship to meet the circle described by the end of the tillar at *d*, will give the position for the standing part of the rope; and the point *f*, set off $\frac{1}{2}$ of the length *ab*, or the length of the tillar from *b*, squared across the ship; and *fe*, taken as $1\frac{1}{4}$ of *cd*, will give the point for the station of the tillar block at the side of the ship. These points, thus practically determined, will ensure that the rope, roved through blocks placed at them, will move the tillar through the angle of 45° from the midship position on each side without any slack rope being caused by it. On this deck, at the extreme after end of it, the mess-place of the midshipmen, or what is termed the gun-room, is situated, formed by the after part of this deck being separated from the whole by a bulk-head or screen.



MAIN OR UPPER DECK.

This platform, on which the guns — not so heavy — those placed on the lower or gun deck, is termed by naval men the main deck, while by the shipwright it is called the upper deck. From the ——— it inherits this seeming contradiction in name from this deck having in former times been the place to which all the ——— were led for working the sails of the

"main" point or centre of the evolutions of the ship. The shipwright calls it the upper deck, in consequence of its receiving ■ perfect upper line of battery, or that the guns on it range fore and aft of the ship, ■ through her whole length.

On this deck, in addition to the arrangements required for the efficient working and training of the guns, riding bitts have been placed in modern times for anchoring the ship; and ■ it all the requirements in the shape of bitts and sheaves ■ still fitted for working the sails ■ heretofore, though they ■ not generally used, except in bad weather. This platform at the after part is divided off into small ■■■ or cabins, each inclosing a gun, to form the sleeping berths of the ward-room officers of the ship; consisting of a commander, lieutenants, master, surgeon, purser, and marine officers. The centre part, between this row on each side of small bedrooms, is apportioned as a mess-room for these officers. This arrangement includes also a steward's room or pantry, and other requisites for ensuring the comforts of gentlemen who, under the most favourable circumstances, have not in their possession the most enviable berth under the service of the Crown.

QUARTER DECK, WAIST, AND FORECASTLE.

On the forecastle, or foremost part of this deck, the necessary mechanical expedients for bringing the anchor from the water when raised by means of the capstan (*vide* Appendix), to its surface are placed. Two horns, ■ they may be termed, ■ fixed one on either side of the ship outside, and ■ called cat-heads; each of these have sheaves or pulleys in their outer ends, and have ■ rope passed through them, and ■ block termed a cat-block to form a tackle or pulley; the block having ■ large hook worked as a part of the binding or holding of it, which hook is called ■ cat-hook; and this it is which is hooked into the ring of the anchor when it appears above the water and the anchor is thence, by the purchase or power which has been

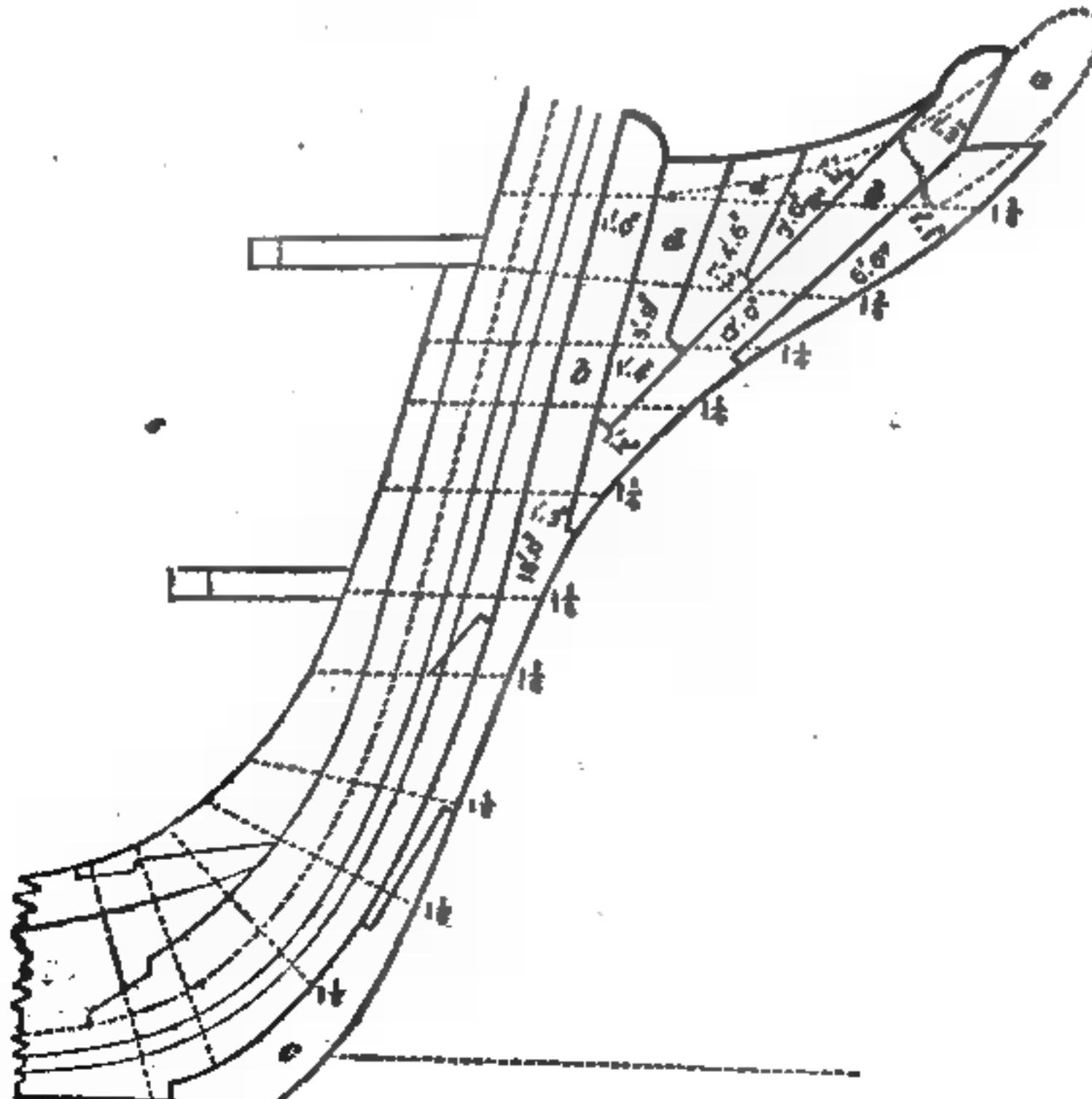
in this position it is denominated as being at ■ cock-bill. To raise the lower end of the anchor, or technically to fish it, and stow the flues or spade-like arms of it against the side of the ship, an outrigger with tackles, called a fish-davit, is used ; the anchor then usually lays with the shank to the sheer or longitudinal line of the side of the ship, and the pea of it, or the extreme point of the flue, rests on what is mechanically termed a bill-board. To keep the anchor in this position there are cat-head stoppers or lashings and shark painters or ties, and these have various ingenious contrivances for facilitating their being let go, when required for anchoring the ship ; those usually fitted were invented by ■ Mr. Spencer of Chatham Yard, and are known in the service by the name of Spencer's slip-stoppers. Mr. Blake, lately master shipwright of Portsmouth Yard, has also ■ fitting or method for the same desirable end ; but the nut-shell which this rudimentary work presents for the reception of even the mere technical terms adopted by the shipwrights, must and will be received as ■ just and sufficient reason for no details being given of these useful inventions. There are on the forecastle holes through the bows of the ship, called fair leaders, for the ropes called sheets, connected with the head sails or those by which they are strained to the wind. Bolts are also placed round the masts to receive blocks for ropes to lead through from the respective yards and sails on the fore mast; and to the side of the ship immediately in the wake of the shrouds (or supports made of rope) to the lower masts, pin-racks, or pieces of wood with sheaves or pulleys in them to receive ropes and pins to which to belay those ropes, are bolted. In the waist, or between the fore and main masts, the heavy boats, called severally the launch and pinnaces of the ship, ■ stowed ■ what are termed the skid-beams ; the deck of the forecastle and quarter decks ■ stopped short at the waist amidships, which is thus left open ; the passage to and from forecastle to quarter deck being preserved by the ladders.

The main mast has bitts round it and pin-racks similar to the fore mast. The cabin for the captain is on this deck, under another after deck, which is termed the poop. Guns are carried on the forecastle and quarter deck, but not any to the waist or ■ the poop, except in the ships of modern construction, which have been armed with large guns to meet the steam warfare. On the outside of the ship, at the height of the poop-deck, long pieces of wood or of iron, named davits, are fixed for hoisting the boats, carried ■ the quarters, out of the water and securing them while at sea. Similar davits ■ fitted to the stern at the ■■■ height. On the stern also ■ life buoy on each quarter is fixed; means being furnished for letting it overboard immediately in the day-time, should a man fall into the water; and should a similar accident occur at night, the life buoy is so ingeniously contrived that ■ port-fire can first be fused or lighted, and then the buoy be let go, presenting by the light thus shown, ■ greater chance for the man to discover the buoy in ■ dark night, and for a boat from the ship to find both man and buoy, should he have been successful in reaching it. This description of buoy, which has for many years been fitted to all ships in the British Navy, was invented by Lieutenant Cook of that service, who must feel heartfelt gratification in having thus been the means of saving from ■ watery grave many a brother sailor.

On the rough treerails all round the ship, what is termed hammock netting (see sketch of Hammock Netting, p. 71), is placed for the reception of the hammocks or beds of the sailors, which are stowed or placed in them during the day for a two-fold purpose: one, of forming ■ protection for the men from the effects of the fire of the small arms of ■ enemy during an action; and the other to have a clear ship below during the day-time. The men in a line-of-battle ship usually sleep, or, as it is technically called, "hang up," on the lower deck, or the deck which carries the tier of guns nearest to the water; and the hammocks when brought ■ from below, and stowed in the

painted canvas, termed hammock cloths. On the outside of the ship, arrangements are made for the rigging and sailing of her. The sketch below, marked Knee of the Head, shows the formation of the fore extreme of the vessel beyond the stem, giving the contour considered necessary for the appearance of the ship, and forming a base for the security of the bowsprit, by what is termed the gammoning; it also affords space for the arrangements required in the head of a vessel for a crew so numerous as that of a man-of-war. The figured dimensions are the sizes of bolts, in inches, driven in the knee of the head of a small man-of-war for fixing it. The channels, or outriggers to the shrouds or the supports to the lower masts, are the heaviest work. The breadth of them from the side is governed so that the shroud

Sketch of Knee of the Head.

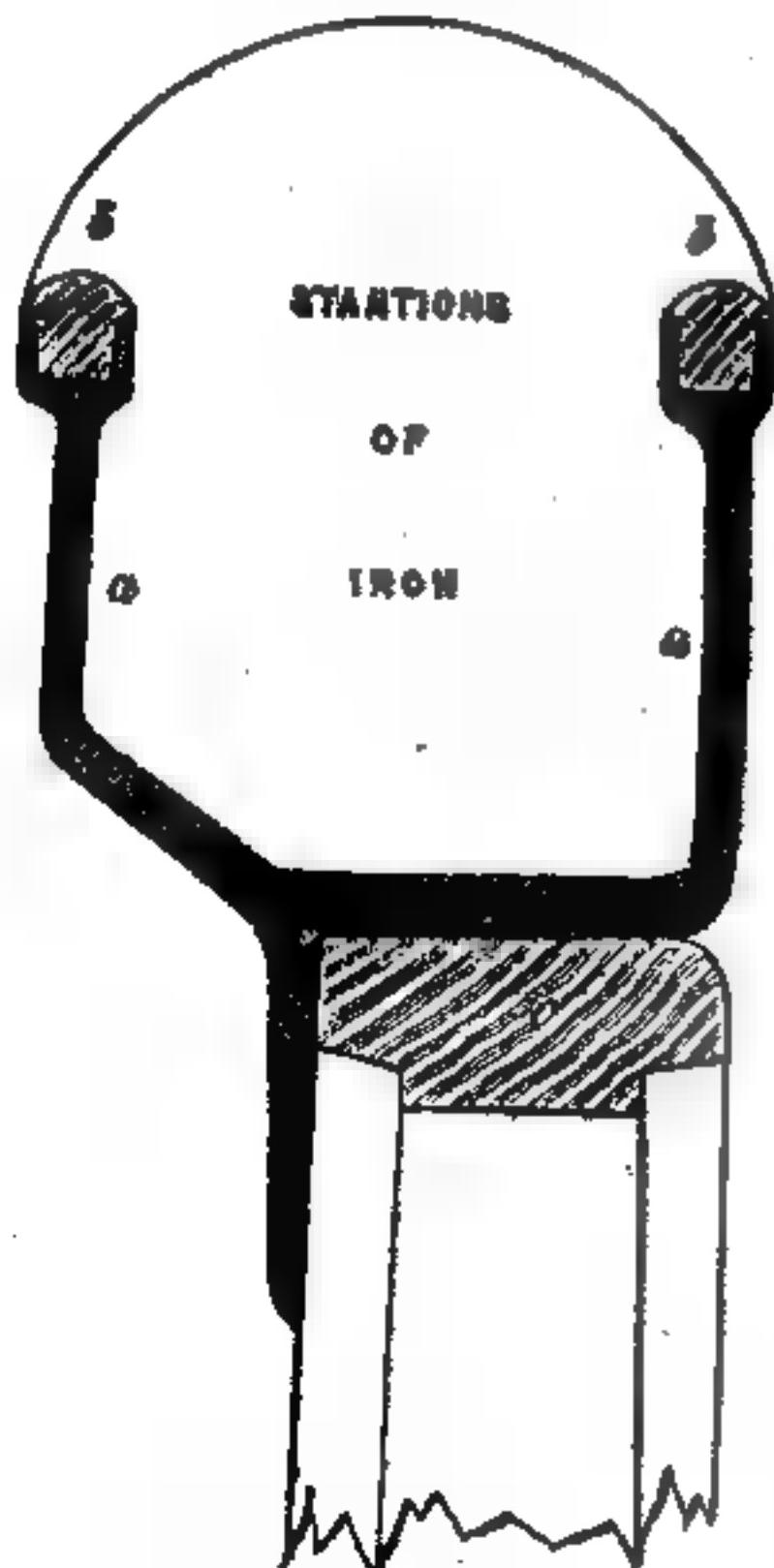


a, Figure head. b, Independent piece. c, Gripe. d, Chocks to fill up the knee.

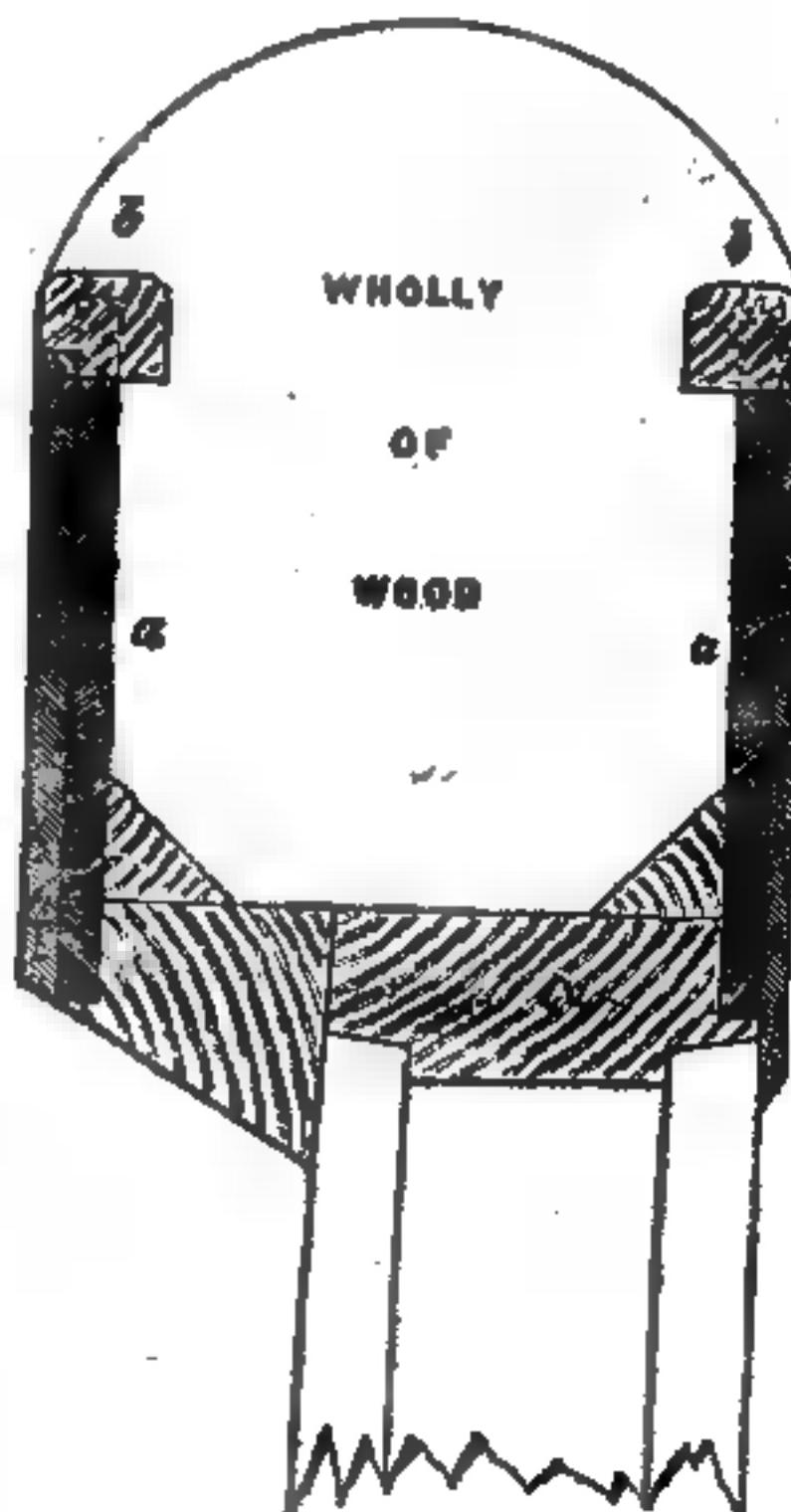
or rope, when in place, may be 6 inches clear of the hammock rail (see sketch of Hammock Berthing.) The chain plates, — they are styled, are sometimes formed of links of iron. Bars of iron at other times form the communication from the rigging to the side of the ship. Great objections have been urged against the use of channels, — being subject from their exposed situation to be damaged by the force of the sea, and that of collision, should vessels run into each other; and plans have thence been put forward that in some cases have brought the direct strain from the masts to the upper side of the top side, to its manifest injury, and to the insecurity of the masts: while in others the channels have been formed by mere

Hammock Nettings.

No. 1.



No. 2.



No. 1.—(a) Hammock stantions of iron, with horns to receive the rails b.
 (b) Rails, ■ inches by $2\frac{1}{2}$ inches, to form with berthing ■ board of ■ inch thickness, boxes for and aft the ship for the hammocks. (c) Rough treerail.
 No. 2.—The same, made wholly of wood; with the same references.

bolsters worked on the side. The latter may be effective when used in ships where the breadth or width of them is unnecessarily great, and where great falling in of the sides has been the form given to the top sides of the vessel; and the removal of the channels from the sides of merchant ships may be desirable, from the convenience thereby afforded for their being placed in tiers or rows in a harbour, when lashed alongside of each other. At the bows, or fore part of the vessel, on each side, a wooden or iron outrigger, termed a boomkin, is placed to receive the lower end of the fore-sail, or what is called the fore-tack. There are also blocks or sheaves or pulleys let through the sides of the ship to admit the ropes which confine the ends of the sails, which ropes are technically termed "sheets;" thus there are fore and main sheets, boom sheets, &c. A ladder is also in these modern times fitted outside the ship, from the edge of the water to the gunwale at the entering port, which affords accommodation to visitors and the officers of the ship: in former times such things were considered unnecessary. The boom for the lower studding sail, or outrigger for that sail on the fore mast, is made to answer in harbour when the ship is at anchor — the security of the boats while afloat, and is not unaptly styled the guest warp boom, from the boats of visitors being secured to it while they are on board. There are other minor fittings which are required to make perfect the hull and the requisites for the sails used for moving such a vast body as a ship of war; and the minutiae of them would, if given, be only intelligible to those whose paths are on the deep. A rudimentary work, as being the boat to the ship of science, is not intended or expected to carry the whole cargo of the ship at one trip, but this small work, although thus restricted, may nevertheless be productive of essential good, by giving to the youthful mind a bias towards the attainment of useful and practical knowledge upon the subject of naval architecture, involving as it does the welfare

PART XIV.

Measurement of a Ship or Vessel by the old Rule for Tonnage.—Rule given in detail.—Remarks on the Causes of the Rule as being a faulty Approximation to the true Capacity of a Ship.—Rule practically applied to the Measurement of a Man-of-War.—Diagram showing the Method of applying the Rule.

Measurement of the Tonnage of a Ship, or a supposed approximation to her Capacity for carrying Cargo, by the old System of ascertaining what is termed the Builders' Tonnage of her.

THE general terms of this rule are these: that Burthen in tons = *Length of Keel for Tonnage* × *Breadth for Tonnage* × $\frac{1}{2}$ *Breadth for Tonnage*, divided by ninety-four.

These terms are determined by the draught of the ship, or taken off from the vessel when built, according to the following APPARENTLY arbitrary considerations:—

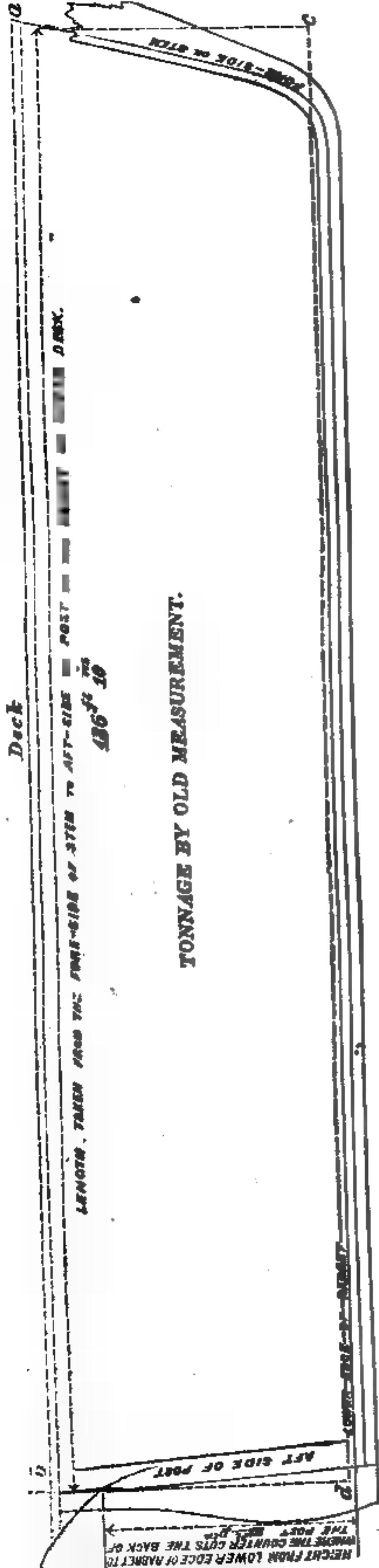
LENGTH OF THE KEEL FOR TONNAGE.

The capacity of a body is comprised under three dimensions; length, breadth, and depth. It would thence seem, that in forming a rule that was to ascertain the capacity of a ship for cargo, a length was taken that might fairly be considered to comprehend that portion of her which could be occupied by her lading, which length was called “Length between the perpendiculars for tonnage.” This dimension by the rule is ordered to be taken as follows: The fore extreme to be at the fore side of the stem (*a*, sketch for Tonnage), at the height of the upper deck in two-decked ships of war, frigates, single-decked vessels, and merchant ships, and the middle deck of three-decked ships; and the after extreme to be at the back of the main post (*b*), at the height of the wing transom in square-sterned ships; and in ships with elliptical sterns, where the same height of the upper deck of two-deck ships, &c., or

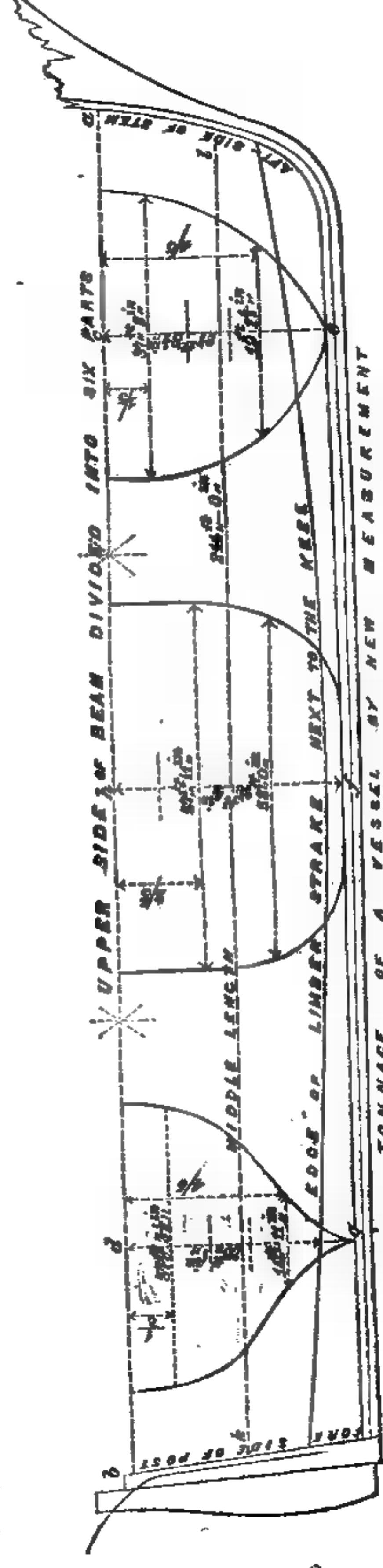
counter; these points to be squared down to the line of the lower edge of the rabbet of the keel produced, and the distance between these intersections to be the "length between the perpendiculars for tonnage" (*c d*). This length, if taken as a measure of the length for capacity, would manifestly be doing so without regard to any contraction of the length in the lower part of the hold of the ship, which might arise from the rake given to the extremes, or that of the stem and stern post; but the rule, with a view to meet this consideration, diminishes the "length between the perpendiculars for tonnage"—first, for the rake of the stem, and, secondly, for the rake of stern post. The deduction to be made for the rake of stem is to be obtained by taking $\frac{2}{3}$ ths of the "breadth for tonnage;" while that for the rake of the stern post is to be the result which arises from allowing $2\frac{1}{2}$ inches for every foot that the upper side of the wing transom at the middle line, in *square-sterned* ships, is above the lower edge of the rabbet of the keel (*c d*), or the same ratio per foot in ships with elliptical sterns, for the height of the intersection of the counter line with the back of the main post above the same base; and the sum of these two estimated deductions is to be taken from the "length between the perpendiculars for tonnage," to give the "length of the keel for tonnage."

BREADTH FOR TONNAGE.

A dimension to be obtained by subtracting from the extreme breadth of the ship, at the height of the wales, the excess in thickness of the wales over the thickness of the plank of the bottom; thus a ship is in breadth from outside to outside of the wales 60 feet—the wales being 10 inches thick, and the bottom plank 5 inches; the excess of the wales in thickness over that of the bottom plank would in this example be 5 inches on each side; which gives 10 inches to be deducted from the extreme breadth of 60 feet for the "breadth for tonnage," so that the "breadth for tonnage"



TONNAGE BY OLD MEASUREMENT.



The "keel for tonnage" and "breadth for tonnage" of a ship having been thus estimated, the builder's tonnage of her ■ shown by the equation will be known, by multiplying the "keel for tonnage" by the "breadth for tonnage," and that product by "half breadth for tonnage"—the last product being divided by the number 94: the quotient thence arising will be the number of tons the ship ■ formerly registered ■ being able to carry. This rule, used as the test of the quantity of cargo that a vessel can carry, is absurd, one dimension which is so essential towards ascertaining the real capacity of her being left out in the calculation, viz., the depth; so that two ships having the same length and breadth, but the one being double the depth of the other, would nevertheless bear nearly the ■ nominal tonnage: in fact, the deeper ship would be the lesser one in tonnage, from the greater height of the wing transom (*a b*) in her above the lower edge of the rabbet of the keel, causing a larger deduction to be made for ascertaining her "keel for tonnage," giving thereby a less length for it and consequently for calculation; while it will be easily understood, that the double depth, all other things remaining the same, could not fail to give to the smaller registered tonnage vessel by rule, the power of carrying double cargo. It ■ this anomaly that tied the hands of the British merchant shipbuilder from making ■ effort towards any improvement in the forms of the mercantile navy of this country, and made the ships for commerce square and deep boxes with the ends rounded off for steerage: attempts have been made to dispel this bugbear to good properties in the ships forming the mercantile navy of this country; and, having given ■ practical example of this ancient method—for it is still perpetuated in the navy, where it is used as forming ■ standard of comparison only—another rule will be given, authorized by act of Parliament, by which it has been endeavoured, through the means of ■ series of internal measurements, to form ■ approximation to the cubical contents of the internal space or hold of ■ ship which it is intended should be occupied by the cargo or lading.

Example of the Old Measurement of Tonnage on a Vessel of the following Dimensions.

	Ft. in.
Length between the perpendiculars for tonnage," — <i>a b</i> of fig.	180 10
Breadth, extreme, from outside to outside of wales	49 5½
Wales in thickness	0 8
Bottom plank in thickness	0 4½
Excess of the thickness of the wales over that of the bottom, 3½ inches, or both sides	0 7

From which the "breadth for tonnage" for using the rule will become — follows :—

	Ft. in.
Breadth from outside to outside, as above	■ 5½
Excess of wales over plank of bottom	■ 7
" Breadth for tonnage"	48 10½

Whence, for rake of stem, $\frac{2}{3}$ ths of the "breadth for tonnage" equals $\frac{2}{3}$ ths of—

$$\begin{array}{r}
 \text{Ft. in.} \\
 48 10\frac{1}{2} \\
 \times 3 \\
 \hline
 5)146 8\frac{1}{2} \\
 \hline
 \blacksquare 4
 \end{array}$$

Which is the deduction that is to be made, according to the rule, from the "length between the perpendicular for tonnage" for the rake of the stem of the vessel.

The deduction to be made in feet and inches for the rake of the stern post will in this example be found, by the height of the wing transom above the lower edge of the rabbet of the keel, as (*d b*), being taken by measurement; and, supposing it to be 22 feet 9 inches, the ratio of $2\frac{1}{2}$ inches for every foot of that height will give the — to be subtracted—thus

$$\begin{array}{r}
 \text{Ft. in.} \\
 22 " 9 \\
 - \blacksquare 2\frac{1}{2} \text{ inches} \\
 \hline
 \text{inches } 45 " 6 \\
 11 " 4 \\
 \hline
 \text{divided by } 12) 56 " 10 =
 \end{array}$$

The deduction to be made from the "length between the }
perpendiculars for tonnage" for the rake of the stern post } = $\frac{4 " 8\frac{1}{2}}{ }$

Whence, adding these two together, viz.—

	Ft. in.
Deduction to be made for the rake of stem	29 4
Ditto ditto ditto post	4 8 $\frac{1}{2}$
	<hr/>
	24 0 $\frac{1}{2}$

Will give the total reduction in feet and inches that must be made in the "length between the perpendiculars for tonnage" to obtain the "keel for tonnage" of the rule; or the "keel for tonnage" in this particular example will be found by taking from—

Ft. in.
186 10 Or "length between the perpendiculars for tonnage."
34 0 $\frac{1}{2}$ = Deductions for rakes of stem and post ■ above.

Leaving 152 9 $\frac{1}{2}$ for "keel for tonnage."

Whence burthen in tons =

"Keel for tonnage" \times "breadth for tonnage" \times $\frac{1}{2}$ "breadth for tonnage".

94

$$152 \text{ ft. } 9\frac{1}{2} \text{ in.} \times 48 \text{ ft. } 10\frac{1}{2} \text{ in.} \times \frac{48 10\frac{1}{2}}{2}$$

$$\text{By substitution} = \frac{94}{94}$$

$$= \frac{152.76 \times 48.9 \times 24.45}{94} = 1942\frac{3}{4} \text{ tons.}$$

In schooners, cutters, and open boats, the "length between the perpendiculars for tonnage" is taken, from where the line of the lower edge of the rabbet of the keel is intersected forward by the squaring down of the fore-side of stem at the bed of the bowsprit, and measuring the length from this point to where the lower edge of the rabbet of the keel, if produced, would cut the aft side of the main post; the deduction from this length for the length of tonnage being only that arising from taking $\frac{2}{3}$ ths of the "breadth for tonnage" for rake of stem; the rake of post being considered as accounted for by the above measurement; the rest of the rule the ■■■■■ as for other ships.

That the perpendiculars placed ■ the draught or drawing for a man-of-war may not be mistaken for the "length between

shall be taken from the aft part of the rabbet of the stem to the fore part of the rabbet of the post at the height of the upper deck.

PART XV.

Measurement of ■ Ship or Vessel by the Rule for Tonnage, enacted by Acts of Parliament of the 5th and 6th years of the reign of William IV.—Rule given in detail.—Rule applied practically to the Measurement of ■ Vessel. Diagram showing the Method of Application.—Necessary Deductions to be made when the Vessel measured by the Rule is to be propelled by Steam.—Short Description of ■ ■■■ satisfactory Method of obtaining the real Tonnage ■ Burthen of ■ Ship, whether intended for War or Commerce.

THE tonnage by Act of Parliament, which, in practice, is designated New Tonnage, was formed to be an approximation to the internal capacity of the ship under the deck or the measurement of the hold in cubic feet of space, and thence to enable ■ determination of her tonnage to be made.

DEPTHES FOR TONNAGE.

Under this rule, it is enacted that the length of the upper deck, or of the upper part of the hold intended to be used for the stowage of goods, be measured at that height from the after part of the stem to the fore part of the stern post; and that such length be divided into six equal parts; and that at the foremost, middle, and aftermost points of division thus fixed, the depths from such points of division to the ceiling or internal planking at the inner edge of the limber strake, or the edge nearest to the middle line, be measured in feet and decimal parts of a foot: the dimensions thus taken are denoted "depths," and ■■ shown ■■ the fig. ■■ *c e, h f, d g.* Should there be a break in the deck, or should the deck not be continued fore and aft the vessel, these depths are to be

measured from ■ line stretched along as a continuation of the deck.

BREADTHS FOR TONNAGE.

Divide the depths at each of the three stations, *c e*, *h f*, *d g*, thus selected, into five equal parts, and at these divisions of the depths measure the *breadths* of the internal form or inside of the ship on lines squared across the ship at the points or positions of the several depths that follow—

c e { Foremost station or division, when { at $\frac{1}{5}$ } and $\frac{2}{5}$ } from the upper deck;
divided into fifths in the depth { and $\frac{3}{5}$ }

h f { Middle station ■ division, when { at $\frac{2}{5}$ } and $\frac{3}{5}$ } from the upper deck;
divided into fifths in the depth { and $\frac{4}{5}$ }

d g { Aftermost station or division, when { at $\frac{1}{5}$ } and $\frac{2}{5}$ } from the upper deck;
divided into fifths in the depth { and $\frac{3}{5}$ }

which measurements are defined on the sketch where the divisions are marked off and given in figured dimensions.

LENGTH ■ TONNAGE.

For the dimension to be used as length, it is enacted, that such length be taken at the height of the middle of the midship depth, on a line parallel with the upper deck, and in length from the after part of the stem to the fore part of the stern post (*k l*). These dimensions of depth, breadth, and length being thus taken, they ■ to be prepared for ■ by the following enacted regulations :—

DEPTHES.

To twice the depth at the midship division, *h f*, add the depths at the foremost, *c e*, and aftermost, *d g*, divisions— which call the sum of the depths.

BREADTHS.

Of those taken from the foremost section, *c e*, add together the breadths taken at the $\frac{1}{5}$ and $\frac{2}{5}$ divisions of the depth of that division.

• Of those taken from the middle section, $h f$, add together three times the breadth at $\frac{2}{5}$, and once the breadth at the $\frac{4}{5}$ division of the depth of that division.

Of those taken from the aftermost section, $d g$, add together once the breadth at $\frac{1}{5}$ and twice the breadth at the $\frac{3}{5}$ division of the depth of that division.

The sum of these multiples of the breadths will give the sum of the breadths for tonnage.

The elements having been thus determined, the enacted rule may now be stated with a chance of its being understood, viz., that:

$$\text{Tonnage} = \frac{\text{sum of depths} \times \text{sum of breadths}}{3500} \text{ length for tonnage.}$$

From a careful inspection of this rule, it will be found that the arbitrary character of the old rule is not wholly lost in the new, and that something yet remains to be done, to make the measurement of a ship for the burthen carried by her as just and certain as the meat weighed from the scales of the butcher: an example of this system is given, and then a method will be suggested which would seem to be not liable to serious errors, and easy of application.

References to the Diagram, p. 75.

$a b$, Length at the upper side of beams, being taken from the aft side (a) of the stem to the fore side (b) of the stern post.

$a c$, One of the divisions of that length, or $\frac{1}{6}$ of $a b$ from (a) on the aft side of stem.

$b d$, One of the divisions of the length, $= a c$, $= \frac{1}{6}$ of $a b$ from (b) the fore side of the stern post.

$c e$, The depth at the foremost division (c), measured from (c) to the point (e), considered well with the upper part of the limber strake $=$ the edge next to the keelson and equal to 27'75 feet. This depth ($c e$) is divided into five equal divisions, and the breadths taken at the depth of $\frac{1}{5}$ and $\frac{4}{5}$, $=$ marked on the fig. $\left\{ \begin{array}{l} \frac{1}{5} = 37\cdot16 \text{ feet.} \\ \frac{4}{5} = 19\cdot12 \end{array} \right.$

$h f$, The midship depth measured = (as for $c e$) 27·4 feet, which is also divided into five equal parts, and the breadths taken on the $\frac{2}{5}$ and $\frac{3}{5}$ depths, as

RUDIMENTARY TREATISE

d g, The depth at the aftermost division $d = 26\cdot0$ feet, measured for *c e* and *h f*, divided into five equal parts, [■] the breadths taken at the $\frac{1}{5}$ and $\frac{3}{5}$ depths, as marked in the fig. { [■] = 37.27.
{ [■] = 14.90.

k l, The length taken through the middle division of the middle depth, being the length [■] that height from aft [■] of the [■] to the fore side of the post, being [■] the fig. 214 ft. 0 in.

These dimensions will yield the following results by the rule:—

SUM OF THE DEPTHS.

	Feet.	Multiplier by rule.	Feet.
<i>c e</i> , Fore depth	= 27.75	$\times 1$	= 27.75
<i>h f</i> , Midship ditto	= 27.4	$\times 1$	= 54.80
<i>d g</i> , After depth	= 26.0	$\times 1$	= 26.00
Sum of the depths			108.55

SUM OF THE BREADTHS.

	Feet.	Multipplier by rule.	Feet.
Fore division, <i>c e</i> , at $\frac{1}{5}$ depth. Breadth = 37.16	$\times 1$	= 37.16	
" " " $\frac{3}{5}$ " " " = 19.12	$\times 1$	= 19.12	
Middle division, <i>h f</i> , at $\frac{3}{5}$ depth. Breadth = 37.9	$\times 1$	= 118.70	
" " " $\frac{4}{5}$ " " " = 28.0	$\times 1$	= 28.00	
After division, <i>d g</i> , at $\frac{4}{5}$ depth. Breadth = 37.27	$\times 1$	= 37.27	
" " " $\frac{5}{5}$ " " " = 14.90	$\times 2$	= 29.80	
Sum of the breadths by rule			265.05

k l, Length for the tonnage taken at the height of the middle division of the midship depth = 214 ft. 0 in.

Whence, in this example,—

$$\text{Tonnage} = \frac{\text{sum of the depths} \times \text{sum of the breadths} \times \text{length for tonnage}}{350} = \frac{108.55 \times 265.05 \times 214.0}{350} = 1759 \frac{531}{500} \text{ tons.}$$

In applying this rule to steam vessels—the [■] method is to be pursued, and [■] deduction to be made from the result

for the cubical contents of the engine room, which contents are to be estimated as follows:—Measure the inside length of the engine room in feet, and decimal parts of a foot, from the fore to the after bulk head of such engine room—then multiply the said length by the depth of the ship at the midship division, $h f$, aforesaid, and that product by the inside breadth at the same division, $h f$, taken at $\frac{1}{3}$ of the depth from the deck, or as before taken, 97·9 feet; this product divided by 92·4 will give a quotient that is to be considered the tonnage due to the cubical contents of the engine room, and further, the amount to be deducted from the calculated tonnage by the rule; and by the 1834 Act of Parliament it is further enacted, that the tonnage of all ships or vessels, whether belonging to the United Kingdom or otherwise, if there shall be occasion to measure them while their cargoes are on board, shall be computed by the following rule and dimensions:—

1st. The length on the upper deck between the after part of the stem and the fore part of the stern post.

2ndly. The inside breadth on the under side of the upper deck at the middle point of the foregoing length.

3rdly. The depth from the under side of the upper deck, down the pump well to the limber strakes or internal plank.

With these three dimensions ascertained, the Act directs that the product of the three, viz., length multiplied by breadth, and their product by the depth, shall give a result which, being divided by 130, the quotient shall be considered as an approximation to the true register tonnage of the ship, or her capacity for carrying stores and cargo.

The most effectual method to ascertain the tonnage of ships employed in the merchant service would be, that the draught of water of the vessel when she is fully equipped and stored for sea, but without cargo in her, should be taken and registered by the officers of the customs, such draught of water being also cut in on one of the main beams of the vessel in a manner similar to that now required for the tonnage; and in

all vessels built in England, a scale of displacement formed as described in the Elementary Rudiments of Construction should be cut in on the ■■■ beam of the ship—when the difference between the displacements, given per scale, by the ■■■ draught of water of the ship when light and that when loaded (be it what it may), will be the actual amount of tonnage or burthen the vessel has carried.

In foreign vessels, over which the government of this country has no control, and can thence not enforce a similar proceeding for them while building, let the draught of water be carefully taken in the English port in which they intend to discharge their cargoes, previously to their breaking bulk, and let it also be taken after the ship has been fully discharged of her burthen: the difference between the mean draughts of water of these two immersions, or those arising from adding (in each case) the draught of water forward to that aft, and taking the half thereof, will give the rising of the vessel bodily in the water in feet and inches; and it is not difficult at half way of that emersion to calculate from the ship the ■■■ of the level section of her, and equally easy to find the capacity due to an inch of immersion at that line. As this latter would form the average capacity of the vessel to ■■■ inch immersion, the whole lading or weight would be tolerably accurately given by reducing into inches the difference shown in feet and inches between the mean draught of water when loaded and that when the cargo is discharged, and multiplying the result by the capacity per inch before determined. The task is within the attainments of a ■■■ of ordinary abilities, and could be accomplished in a much shorter period of time than ■ first judgment of such ■ proceeding would surmise; and as these ships are usually employed between the same ports, once done, the operation would not require to be repeated.

PART XVI.

Mechanical Power used for Launching.—Declivities of Slip and of the Blocks the Vessel is built on.—Sliding ways.—Bilgeways.—Inclination of Sliding ways.—Upper side of Sliding ways, whether straight or cambered.—Rib-bands.—Method used by the French in Launching.—Method described of putting the Bilgeways on the Sliding ways.—Stopping-up Pieces.—Poppets.—Cleats on the Bottom.—Dagger Planks.—Paying with Tallow Bilgeways and Sliding ways.—Setting up the Ship.—Removing the Building Blocks.—Christening.—Dog-shore.—Launch of the Ship.

THE LAUNCH OF THE SHIP.*

THE ship having been completed on the building slip, the next step is to place her in the water, which apparently Herculean task is accomplished in Her Majesty's naval arsenals by a method of which the following is an outline.

The mechanical power designated the "inclined plane" has been made available to the moving into the water such a vast fabric as the first-rate man-of-war whose armament is to be 120 guns and the hull of which weighs at the least 2600 tons. The slipway (*a*) on which the vessel is built is to this end an inclined plane, and the upper surface of the blocks on which the ship rests while building and which received the keel, the first assemblage of timber used in her practical construction, is made to partake of the same property; by which means the ship, while under practical construction, lays inclined to the horizon at an inclination of $\frac{1}{8}$ ths of an inch to a foot in her length, or at nearly that of 1 foot in 19 feet below the horizontal plane marked *b*, in the Plate of the Launch.

The weight of the ship has to be transferred from these blocks to a cradle or support for moving her down two narrow inclined planes, one on either side of the keel of the ship. These narrow planes are denominated the sliding ways, and they

so placed on the slip that the outside of the bilgeways, or the foundation of the cradle which supports the ship while launching, shall be $\frac{1}{6}$ th of the main or greatest breadth of the vessel from the side of the keel, which will give the bilgeways a spread, from the outside of the one to the outside of the other, of $\frac{1}{3}$ rd of the main breadth of the ship, and the breadth of the keel in addition. The bilgeways is a technical term given to a long assemblage of timber, combined to form the basis of the cradle in which the ship rests when launching. The sliding ways may justly be termed the rails or trams to receive the bilgeways and cradle, which latter may be said to form the carriage or truck to carry the ship into the water. The sliding ways are composed of blocks of wood laid to a determined height to receive planks of 3 inches in thickness and 10 inches in width, forming on the upper surface inclined planes of about 3 feet 4 inches in width, $\frac{d}{4}$ of Plate. These planks are usually laid on the blocks with close joints; but experience and reflection point out that their being kept an inch apart is more efficient, practice having taught the lesson that powerful adhesion takes place by reason of the exclusion of the atmospheric air from the surfaces in contact; viz., those formed by the upper sides of the sliding ways and the under sides of bilgeways, and these being too perfectly in contact, an adhesion has to be overcome, which requires great force to be used in starting the ship, whereby delay is sometimes caused in launching.

The bilgeways should be in length at least $\frac{5}{6}$ ths that of the ship, or, for a first-rate of 120 guns and 205 feet in length, the bilgeways should be 170 feet, their breadth and depth being about 2 feet 6 inches square. The breadth of the bilgeways will determine that of the sliding ways, and also the position of them, regard being had to the limit before given, for the extreme spread of the bilgeways; the sliding ways then to be allowed sufficiently wide beyond the outside

to prevent the bilgeways from being forced outwards by the weight of the ship while launching. The foremost piece of ribband on each side is of oak, as it becomes the abutment of the after end of ■ piece of timber which is called the dog shore, ■ of Plate, the fore end of which butts or stops against large cleats, ■ of Plate, ■ the bilgeways, forming ■ preventative against the bilgeways (*e*), slipping down the sliding ways (*d*), and constituting the means by which the ship is retained ■ them (*d*) until the time has arrived for launching her. The foremost pieces of ribbands, the better to enable them to resist the strain brought on them, ■ bolted and dowelled to the sliding ways ; and to prevent the bilgeways from being forced inwards, shores (*s*) are placed on cleats from the sides of the keel to the insides of them. The inclination to be given to the sliding ways is governed by the size of the ship, and the rise and fall of the tide ; to which considerations may be added the inclination of the slip ■ which the ship is built. In the Queen's service the slips ■ nearly all built at the same inclination to the horizon.

The smaller vessels require the most inclination to be given to the sliding ways, and on some occasions they have had ■ much given to them as $1\frac{1}{2}$ inches to ■ foot, to afford ■ impetus to their comparatively light weight of hull ; the larger ships, from first-rates to frigates, have usually from $\frac{3}{4}$ ths to $\frac{7}{8}$ ths of an inch in a foot declivity, and it has been found in practice that the inclination of $\frac{3}{4}$ ths of ■ inch has given to the vessel the velocity necessary for safety and efficiency.

It ■ formerly the practice in Her Majesty's service for the upper side of the sliding ways to be formed in their length to an arc of ■ large circle, which ■ technically termed cambering the ways. This method has been considered in modern times objectionable, as tending, it is said, to break the vessel, or to alter her form lengthways ; this objection will not hold good if the ways ■ the arc of a large circle for their whole length ; but if it is only such from the after end

would be detrimental to the vessel, ■ the bilgeways would then alter their form from the straight line to the arc, which would thence allow of that change of longitudinal form in the ship which is denoted breaking.

The advantage that is said to arise from cambering the sliding ways is founded on the following consideration :—that should the groundways not be firm, the weight of the ship, when the upper surface of the ways is laid straight, would force it into a concave one, which would be detrimental to her starting ; in the case of the ways being cambered, the form of them being thence that of an arch, the upper surface of them would be better preserved.

The French launch their ships-of-war on their keels, having side bilgeways merely to steady the ship ; the stability of the groundways must be the main source, in both systems, of keeping the forms of the ships unaltered in launching. In the method used in the English naval arsenals, care must be taken to ensure that the fore foot of the ship launches clear of the slip, which will always be the result if the declivity given to the sliding ways be less than that of the slip ; should the contrary be the case, the height of the foremost block on which the vessel ■■■ built, the length of the slip, and the proposed declivity, must be considered, to prevent the fore foot of the vessel from striking the groundways of the slip at the lower end of it. The slide beyond the slip is laid during the recess of the tide, either on piles driven for that purpose, or on permanent groundways.

The bilgeways having been hauled up on the sliding ways and placed under the bottom of the ship, in their position, as before described, of $\frac{1}{6}$ th of the main or principal breadth of the vessel from the keel, large pieces of fir, called stopping-up pieces, are placed on the bilgeways in the middle part of them to meet the bottom of the ship ; but at the fore and after parts, where the form of the vessel, from its sharpness,

upper side of the bilgeways to the bottom of the ship. These timbers are called poppets (*k* of the Plate), and are usually formed of square fir timber termed baulk; the heads of them are prevented from flying off the bottom of the ship by their being confined to it by the lower edge of a plank bolted to the bottom of the ship; this plank having likewise cleats (*n' n'*) screwed to the bottom of the vessel, to support the upper edge of it. The lower ends or heels of the poppets rest on a plank called a sole piece (*ll*), which is placed on the upper side of the bilgeways; the sole piece having a groove taken out of the centre of it to receive tenons raised in the heels of the poppets. The poppets are usually their dimensions apart. The whole of the after poppets, except the extreme after three, and all of those forward, except the extreme forward ones, are placed plumb, or square to the horizon. The foremost three poppets are placed with the heels of them forward, to make them stand a-shores against the heads of the other fore poppets, when the ship's bows in launching are pressed to the sliding ways by reason of the excess of buoyancy of the after body of the vessel.

These poppets are united to the stopping-up which is worked on the midship portion of the launching cradle by planks, which are denominated dagger planks. The ribbands (*g*), which are placed on the sliding ways to confine the bilgeways on them, have greater spread or space given between them than that given to the bilgeways themselves. This excess of space is termed "play," and is usually $\frac{3}{4}$ of an inch at the fore end of the bilgeways, and 1 inch at the after end of them on each side, spread out at the extreme end of the slide to $2\frac{1}{2}$ inches. The bilgeways are usually what is termed "turned out" the day before it is proposed to launch the ship, which means that the poppets are taken down and the stopping pieces taken out of their places, and the bilgeways turned over outwards, leaving their under sides to face the keel of the ship. The upper sides of the sliding ways, to the length of the bilgeways, and the under sides of the

tallow, to which, when cool, soft soap is sometimes added in patches; others use oil in preference. The bilgeways ■■■ next "turned in;" the cradle, composed of stopping pieces and poppets, is restored; and the whole, on the morning of the launch, is set to the bottom of the ship, as, between the upper surface of the bilgeways and the lower surfaces of the stopping up and the sole pieces placed to receive the heels of the poppets, large wedges called slices (*o o*) ■■■ placed inside and outside of the bilgeways, and men with mauls or large hammers are stationed to these wedges. By their united and simultaneous efforts, the slices raise the ponderous ■■■ in the cradle, or at least take the weight of the ship from the blocks on which the after part of the vessel rested while building; these blocks under such ■ process become loose or slack, and are removed from under the ship as the tide rises. The fore part of the cradle is not set to the bottom of the ship so firmly, and the weight of the ship rests in part on the foremost building blocks, which are split out from under the ship consecutively, so that shortly before the hour of launching, or high water, the mighty fabric may be seen from aft resting on the sliding ways, suspended, as it were, in the air, on two comparatively narrow ribbands, and man's ingenuity and skilful perseverance seem triumphant. At this stage of the exciting scene, the vessel is christened by wine being thrown against the bows, or fore part of her, and her name given to her, after which the word is given to "down dog shore," and the ship, the fruits of years of labour and anxiety, freed from the last fetter that binds her to the stable earth, passes into the element in which she is destined to bear the battle's bront and the merciless peltings of the howling tempest.

References to the Plate of the Launch, ■■■ descriptive of the foregoing text.

■ Groundways of the slip, which, in Her Majesty's arsenals, is laid at the declivity of $1\frac{1}{4}$ inch in a foot.

- c' Section of the building blocks. The inclination of these blocks from the horizon is 1 foot in 19 feet.
- d Section of the sliding ways as composed of blocks and planks.
- Section of the bilgeways laid on the sliding ways, the outside of the ■ bilgeway being apart from the outside of the other $\frac{1}{8}$ the main ■ greatest breadth of the ship, together with the breadth of the main keel.
- f Section of the bilgeways lengthways.
- g Ribbands, ■ square pieces of fir, secured to the sliding ways to prevent the bilgeways from spreading or being forced out when the ship is launching.
- h Inclination given to the sliding ways, being usually from $\frac{1}{8}$ to $\frac{1}{6}$ of inch to ■ foot.
- i i Stopping-up amidships, composed of large pieces of fir.
- k k Poppets or shores before and abaft the stopping-up pieces.
- l l Sole-pieces or planks worked to receive the lower ends or heels of the poppets (k k).
- m m Dagger planks to connect the poppets (k k) with each other, and unite them with the stopping up (i i).
- n n Planks worked to the bottom of the ship, to confine the upper ends or heads of the poppets (k k).
- n' n' Cleats to support the plank (n n). They are screwed to the bottom.
- o o Slices or large wedges placed between the sole-pieces, stopping-up and bilgeways, to set the launch to the bottom of the ship, and take the weight of the vessel off the building blocks (c).
- p Ribband shores to support the ribbands and prevent them from spreading.
- q Dog shore, with its heel resting against the fore end of the foremost length of ribband, and its head against the launching cleat (r) on the bilgeways.
- r Launching cleat to receive the fore end of the dog shore (q). The under side of this cleat (r) should be kept above the upper side of the ribbands (g), ■ in launching the cleat (r) should pass ■ them.
- Shores placed inside the bilgeways, from the ship to the bilgeways, to prevent them from tripping inwards.
- Trigger placed under the dog shore, and removed immediately previous to the launch of the vessel.
- Holes in the ends of the bilgeways, to receive ropes which ■ led ■ board the ship, to secure the bilgeways when the vessel is in the water, as the bilgeways then usually float up from under her.

PART XVII.

Docks—how situated.—Entrance—how closed.—Gates ■ Caissoon.—Vessel's Position ■ the Blocks.—Guys or Ropes—their Use.—Shores, Breast—their Use.—Vessel Upright ■ Plumb.—Method of determining it.—Diagonal Shores—their Position.—Bilge Shores.—Blocks—their Form.—Method of removing the Angular Blocks for False Keel.—Copper Sheathing—when removed.—Places usually defective pointed out.—Defects should be rigidly searched for previously to the Commencement of Repairs.—Advantages arising from such ■ Course of procedure.—Inside and Outside Planking—when and where to be removed.—Beams and Iron Knees to be well examined.—Rudder to be unhung.—Pintle and Braces to be overhauled.—A Plate of ■ Dock with Reference to these Remarks subjoined.—References to Plate 3.

DOCKS OF THE ARSENAL, USUALLY TERMED WET DOCKS.

THE repairs of the ships of Her Majesty's navy and those employed for commercial purposes are mostly performed in what is termed a wet dock, being an excavation lined with wood or stone, made contiguous to the water, and having ■ entrance opening into the river or harbour: the flat or lower part of the excavation or of the dock, in Her Majesty's dock-yards, is usually laid either level, or the after part to be deeper than the fore part, from 12 to 14 inches, and it is below low-water mark, to give a greater depth of water in them, when the vessel has been floated at high water into the dock, in the which blocks have been laid to receive her, similar in other respects, but not inclined, to those on which a ship is built on ■ slip; the entrance to the dock is closed by gates, or by what is termed a caissoon*, and the water at the falling of the tide is let out of the dock through large drains called culverts.

The vessel is placed with her keel immediately over the centre of the blocks, in most instances laid in the middle of the dock, and kept in that position by ropes, technically termed guys, two of such being made fast to each bow, or on either side of the head, and two to each quarter, or on either side of the stern; they are distinguished as being starboard and port, bow

and quarter guys. For the effectual using of these guys, old guns or wooden stumps called bollards (*a*, Plate of Dock) are placed at intervals round both sides of the dock, and at a short distance from it. These form posts round which the guys ■■■ be wrapped to check the ship when she is being hauled into ■■■ out of the dock, and when the dock is unoccupied ropes or chains placed from the one to the other all round it, form a preventive to accidents.

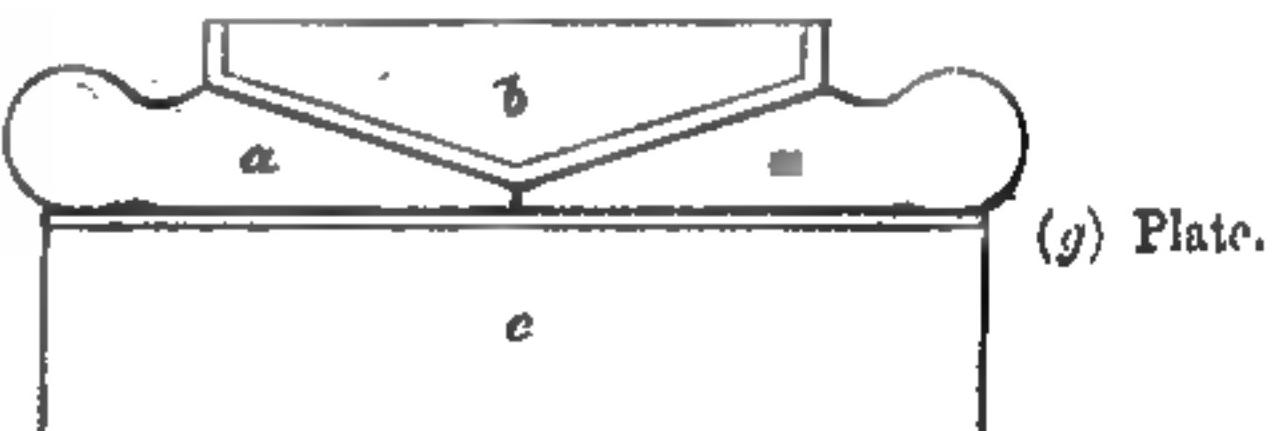
Before the ship, by the falling of the water, takes the blocks, shores or long pieces of timber ■■■ prepared, of such lengths ■■■ to reach from the sides of the dock to those of the ship; and these shores are hung up to the vessel by ropes to the required positions. In the man-of-war their stations are governed by the port timbers, at the height of the deck or beam-ends, ■■■ forming the best security or abutment to them. This tier of shores is called the breast shores (*A*, Plate). But it should be ascertained before grounding, by the means of a plumb line (*f*), whether the ship is upright: should she not be so, the vessel is trimmed by weights on board of her; but if there be none available, the breast-shores, when the ship is firmly grounded on the blocks, are set the ■■■ vigorously on the side which is inclined to, until the vessel is brought to the vertical position; the heads of these shores, or the ends of them, against the sides of the ship should be the highest, that they may not tend to depress her when floated again after the repairs ■■■ completed. Before the breast-shores are set to the ship she is allowed to settle well on the blocks, or the water to drop from her at least 18 inches, that her weight may in part be on them; when, wedges being placed behind the heels of the shores or ■■■ the ends of them, which ■■■ against the sides of the dock, ■■■ to each shore drives simultaneously on the wedges ■■■ both sides of the dock, and she is then secure. As the water further falls, shores, denoted diagonals (*B*, Plate), are placed lower down and between the

Plate); under the breast-shores, when the water is quite out of the dock, which is effected by pumps where the flat of the dock is below the fall of the tide, shores called bilge-shores (d, Plate) are placed, and in ■ large ship having two sets of diagonal shores they will ■■■■■ under the 1st diagonals (B, of Plate).

It should have been said, that before the water is let into the dock, the blocks are examined and well lashed down, and the fore and after ones required to receive her length of keel are marked in position on the upper side of the dock. The bob and mouse lines should also be proved (f, Plate). These lines are to point out the centre of the blocks; they are formed like ■ bricklayer's plumb, the plummet (b) being held over that centre by lines going across the dock, and the sides of the dock give parallel lines to take them fore and aft upon. The line thus fitted, termed the bob, precedes the ship, and that denoted the mouse follows her; the two thus used in conjunction will ensure the vessel being placed immediately over the centre of the blocks.

Angular Docking Blocks.

- Iron wedges.
- Wooden cap, plated with iron on the under side.
- c Block, plated with iron on the upper side.



The blocks fitted in this manner are denoted Sir R. Seppings's angular docking blocks, having been introduced into Her Majesty's service by that officer.

Battering Ram.



* The battering-ram is used to remove the angular blocks when the ship is setting on them, should such be required during the repairs, or for removing the false keel, or caulking the garboard or lower seam of planking (see sketch of Blocks), the ropes *a* enabling men to give a powerful blow on the sides of the wedges *a* to free them: the ends *b* of the rams are armed with iron caps.

In the royal dockyards these angular blocks that the ship rests on while in the wet dock are formed of angular blocks of iron and wooden blocks iron-plated on their surfaces (see sketch, *g* Plate, p. 94). The advantage that arises from the use of these blocks consists in their being easily removed locally from under the ship, their wedge-like form allowing them to be taken from under the vessel in a very short time; and by these means the false keel of a ship may be shifted without the weight of the ship having been taken by shores. These blocks, when restored under the keel, are rammed up by the heavy logs of wood armed with iron at their ends, called battering rams (see sketch, *h* Plate, p. 94), and are thence made again to bear their portion of the weight of the ship. The ship having been placed in the dock and secured by the shores, as before described, if the repairs required are known to be extensive, the copper sheathing is taken off the bottom of her, and planks are split out all fore and aft, in those parts of the ship that past experience has pointed out to be the most likely for decay to arise: such has been found to be the — in the outside planking between wind and water, or more immediately in the vicinity of her line of floatation (*o*); and in the turn of the bilge the timbers of the frame are very subject to rot, from the wood being cut across the grain and the heart of it being thus exposed to wet. In the outside planking above water, the plank immediately in the wake of the channels will often be found defective, from the strain brought on it by the shrouds causing the plank to open, or the topsides of the ship to work; while

of the hawse-holes, from being more subject to wet, are also places that require to be well overhauled. c and b (*vide* Plate of Dock), the waterways and beam ends, are the most exposed to the effects of water by leakage, ■ fruitful source of decay; but to prevent disappointment and unnecessary outlay in the repairs, the ship should be thoroughly opened. All defects should be removed before any new work, or a restoration of her form, is allowed to take place, ■ most serious expenses have been incurred, nay, ships of war have been repaired that would have been taken to pieces, had the defects of the ship been fully laid open in all parts before the first discovered defects had been made good; and it evidences a sound judgment in directing the repairs of ■ ship when a thorough search for defects and the total removal of them before any new materials are provided, much less worked into the ship, is the course pursued. This method of proceeding presents another advantage—that by the timbers of the ship being thrown open to the air for ■ longer time, a check will be given to any incipient seeds of decay, or to the production of fungus. When the repairs to be executed run to a great extent, more especially in the frame of the ship, it becomes ■ matter of serious consideration whether it would not be more advantageous to break the vessel up, using the serviceable portions of her (which will generally be found to be the beams, and the lower timbers of the frame) in the construction of another vessel; should it, however, be deemed advisable still to continue the repairs, the most effective and economical proceeding would be, to take off the topsides outside, ■ low down as the wales, and remove the interior planking up to the same line: this method enables the shipwright to have a full inspection of three sides of each timber; allows the defective timbers to be easily removed, and the new ones to be replaced with facility; and the planking that is retained outside and inside, serves ■ an effectual ribband to preserve the form of the ship. The ends of the beams of the several decks should be examined, by their being bored

with an auger or large gimlet from the side of each in a slanting direction, into the beam-end, but if the outside planking requires to be taken off in the wake of the beam-ends, — efficient external survey of them can be made without recourse being had to the internal one: care should be taken in large repairs that the form of the ship be preserved by means of harpins, ribbands, and shores, where required, similar to those described for ships in building. But it should be with great caution that large repairs are undertaken, the expense attendant on them being more than would arise from building a new ship, from the combination of the two operations of pulling to pieces and putting together again. The knees to the beams of the several decks should be well examined, and any appearance of working—which would be evidenced by the bolt heads being drawn down—should be carefully considered, and an endeavour made to remedy the defect, as the working of the ship on her fastenings is attended with a twofold evil—the one that of rapidly weakening the fabric; and the other, by the assistance of wet, of producing with equal speed the working shipwright's friend—rot, and its consequence—the necessity of extensive repair.

The rudder should be unhung after the woodlock is removed, and the pintles and braces by which it is hung should be carefully examined. The head of the rudder should be well inspected to ascertain if the wooden portion of it has been strained, and that the iron hoops on it are firmly in their places. Too much precaution cannot be used to ensure the efficiency of the rudder, as the lives of the crew and the safety of the ship depend on the perfect order and strength of it.

A sketch of one of the largest wet docks in H. M. dockyards is subjoined, with reference to the remarks that have been made on this subject. In addition to the wet docks that have been described, fitted with gates or caissons to exclude the water, there are in some of H. M. dockyards small open

docks, called graving docks, which admit of a vessel being placed in them and grounded; the fall of the tide leaving the bottom of the ship dry, and allowing any slight defect to be made good before the tide again rises. They were originally constructed for breaming or firing the bottoms of small vessels before the introduction of copper sheathing, when their external planking became foul with weeds; these were always inconvenient for use, and the work being necessarily performed in them under great haste, and thence not efficiently done, they have fallen into disuse.

A DESCRIPTION OF PLATE 3.

Section showing the Timbers of the Frame, and the Positions of the Outside and Inside Planking of a Merchant Ship, with a Reference to the several Parts, giving the Technical Term for each Portion of the delineated Section of the Ship.

- a Half section of the keel.
 - b False keel.
 - c Garboard strakes of outside planking.
 - d Plank of the bottom.
 - e Diminishing plank.
 - f Wales.
 - g Black strakes.
 - h Sheer strakes.
 - i Rough tree rail.
 - j Waterway to quarterdeck.
 - k Shelf to ditto.
 - l Clamps.
 - m Upper deck spirketting.
 - n Upper deck waterway.
 - o Upper deck shelf.
 - p Upper deck clamps.
 - q Lower deck spirketting.
 - r Lower deck waterway.
 - s Lower deck shelf.
 - t Lower deck clamps.
- } Outside planking.

- *m, m, m* Spaces between the thick strakes.
- Side keelsons.
- d* Main keelson.
- k* Head of the fillings of wood, placed in between the timbers as described in the text, under the head of fillings between frame timbers.

The elevation on this plate shows the position of the ports and the trussing between them. The practical carpentry of the ships for commerce, built by Messrs. Smith, of Newcastle, and the firms of Wigram and Green, of Blackwall, of which this section of a merchant vessel may be said to be an outline, bears a close affinity to the work that has been described as the practice of the Queen's service, that the explanation for the one will answer equally well for the other.

PART XVIII.

Principal dimensions of the several rates of Ships in Her Majesty's Navy.—
Armaments.—Weight of Anchors.—Weight of Cables.—Masts and Yards—
—Weight of the Ship.—Weight of the Hull of the Ship.—Weight of
Material received on Board.

FIRST RATE. 120 guns. Tonnage, 2609 tons.
Complement of Men and Officers, 1000 in number.

PRINCIPAL DIMENSIONS.

		ft.	in.
Length on the gun deck		205	0
Length of the keel for tonnage		170	7
Breadth, extreme		53	4
Depth in hold		24	0

ARMAMENT.

	No. of guns.	Weight of each.		Length. Ft. in.
		Cwts.	in.	
Lower deck	32 { 4 of ■ in.	... 65	... 9 0	
	28 32 pdrs.	... 56	... ■ ■	
Middle deck	34 { 2 of ■ in.	... 65	... 9 0	
	32 32 pdrs.	... 50	... 9 0	
Main deck	34 32 pdrs.	... 41	... 8 0	
Quarter deck and forecastle	20 { 6 32 pdrs.	... 45	... 8 6	
	14 32 pdrs. extra.	17	...	
Total weight of the guns				273 tons.
Weight of the broadside in lbs.				2028 lbs.

	Weight of each.	Total weight.
	Tons. cwts. qrs.	Tons. cwts. qrs.
Weight of the principal anchors (4 in No.) .	4 19 0	19 16 0

WEIGHT OF THE CABLES.

	Weight of each.	Total weight.
	Cwts. qrs. lbs.	Tons. cwts. qrs.
3 hempen, of 25 inches circumference .	116 2 20	17 10 0
■ chain, of 2½ inches diameter of link .	243 0 0	48 12 0
		66 2 0
Weight of the anchors		19 16 0
Total weight of the principal cables and anchors . . .		85 18 0

MASTS AND YARDS.

	Length.	Diameter.	Weight.		
			Feet.	Inches.	Tons. cwts. qrs.
Lower Masts	Main	82 ... 40 ...	20	2	0
	Fore	74 ... 37 ...	15	18	0
	Mizen	59 ... 26 ...	5	■	0
	Bowsprit	51 ... 40 ...	12	0	0
Lower Yards	Main	105 ... 25 ...	5	■	0
	Fore	91 ... 22 ...	8	16	■
	Mizen, or cross-jack	71 ... 17 ...	1	8	0
Total weight of the masts and yards			63	15	0
Total weight of the ship, with stores and equipments, to a draught of water of	Afore	24 7	Tons.		
	Aft .	26 0	4670		
Weight of the ball, to a draught of water of	Afore	15 10			
	Aft .	18 ■	2462		
Weight of the material received on board					
			2208		

SECOND RATE. 84 guns. Tonnage, 2234 tons.

Complement of Men and Officers, 750 in number.

PRINCIPAL DIMENSIONS.

		Ft.	in.
Length on the gun deck		196	5½
Length of the keel for tonnage		162	3½
Breadth, extreme		51	5½
Depth in hold		22	6

ARMAMENT.

	No. of guns.	Weight of each.	Length.
		Cwts.	Ft. in.
Lower deck . . .	30 { 6 of 8 in. 24 32 pdrs.	... 65 ... 56	9 0 9 ■
Main deck . . .	32 { 2 of 8 in. 30 32 pdrs.	... 65 ... 48	9 0 8 0
Quarter deck and forecastle	22 { 6 32 pdrs. 16 32 pdrs. carrds.	... 41 17	8 0 —
Total weight of the guns			203 tons.
Weight of the broadside in lbs.			1488 lbs.

Weight of the principal anchors (4 in No.)	Weight of each.			Total weight.		
	Tons.	cwts.	qrs.	Tons.	cwts.	qrs.
	■	5	0	17	0	■

WEIGHT OF THE PRINCIPAL CABLES.

	Weight of each.	Total weight.	
	Cwts. qrs. lbs.	Tons. cwts. qrs.	Tons. cwts. qrs.
■ hempen, of 28½ inches circumference . . .	102 3 12	15	8 2
4 chain, of 2½ inches diameter of link . . .	216 0 3	43	4 0
		58	12 ■
Weight of the anchors		17	0 0
Total weight of the principal anchors and cables		75	12 2

MASTS AND YARDS.

		Length.	Diameter.	Weight.
		Feet. in.	Inches.	Tons. cwts. qrs.
Lower Masts	Main	86 3	40	20 0 0
	Fore	79 3	37	15 12 0
	Mizen	63 2	26	5 6 0
	Bowsprit	51 0	40	12 0 ■
Lower Yards	Main	105 0	25	■ 3 0
	Fore	91 0	22	■ 16 0
	Mizen, ■ cross-jack	71 0	17	1 8 0
Total weight of the masts and yards			63	■ 0

Total weight of the ship, with stores and equipments, to ■ draught of water	Afore	in.	Tons.
	23	0	3721
	24	9	
	Aft		
	Afore	14 3	1959
	Aft	18 9	
Weight of the material received on board			1762

THIRD RATE. 72 to 76 ████ Tonnage, 1740 tons.

Complement of Men and Officers, 650 in number.

PRINCIPAL DIMENSIONS.

		Ft.	in.
Length █ the gun deck		175	9
Length of the keel for tonnage		144	6½
Breadth, extreme		47	8
Depth in hold		21	0½

ARMAMENT.

	No. of guns.	Weight of each.		Length. Ft. in.
		Cwts.	Tons. cwts. qrs.	
Lower deck	28 { 4 of 8 in. 24 32 pdrs.	... 65 ... 56	... ...	9 0 9 6
Main deck	28 32 pdrs.	... 41	... ...	8 0
Quarter deck and forecastle	16 { 4 32 pdrs. 12 32 pdrs. carrods.	... 41 17	... ...	8 0
Total weight of the guns				156 tons.
Weight of the broadside in lbs.				1224 lbs.

Weight of the principal anchors (4 in No.)	Weight of each.			Total weight. Tons. cwts. qrs.
	Tons.	cwts.	qrs.	
	3	18	0	14 12 0

WEIGHT OF THE PRINCIPAL CABLES.

8 hempen, of 22 inches circumference	Weight of each.			Total weight. Tons. cwts. qrs.
	Cwts.	qr.	lbs.	
4 chain, of 2 inches diameter of links	90	1	8	13 11 0
	192	0	0	38 8 0
				51 19 0
Weight of the anchors				14 12 0
Total weight of the principal anchors and cables				66 11 0

MASTS AND YARDS.

	Main	Length.		Diameter.		Weight. Tons. cwts. qrs.
		Feet.	in.	Inches.	Inches.	
Lower Masts	Fore	73	0	35	... 37	10 4 0
	Mizen	57	6	24	... 26	16
	Bowsprit	45	6	36	... 38	5
Lower Yards	Main	82	0	23	... 25	5 0
	Fore	64	0	20	... 22	16
	Mizen, █ cross-jack	64	0	15½	... 17	2 0
	Total weight of the masts and yards					44 17 0

Total weight of the ship, with stores and equipments, to a draught of water	Afore	21	6	Feet. in.	Tons.
	Aft .	23	■		3028
Weight of the hull, to a draught of water	Afore	13	0		1600
	Aft .	17	9		
Weight of the material received on board					1428

FOURTH RATE. 50 guns. Tonnage, 2082 tons. FRIGATE.

Complement of Men and Officers, 500 in number.

PRINCIPAL DIMENSIONS.

		Ft.	in.
Length on the gun deck		176	0
Length of the keel for tonnage		144	6½
Breadth, extreme		52	8½
Depth of hold		17	1

ARMAMENT.

	No. of guns.	Weight of each.		Length. Ft. in.
		Cwts.	Cwts.	
Main deck	28 { 6 of 8 in.	... 65	... ■	0
	22 ■ pdrs.	... 56	... 9	6
Quarter deck and forecastle	22 ■ pdrs.	... 45	... 8	6
Total weight of the guns			130 tons, 12 cwts.	
Weight of the broadside in lbs.			908 lbs.	

Weight of the principal anchors (4 in No.)	Weight of each.			Total weight. Tons. cwts. qrs.
	Tons.	cwts.	qrs.	
	3	10	0	14 0 0

WEIGHT OF THE PRINCIPAL CABLES.

	Weight of each.			Total weight. Tons. cwts. qrs.
	Cwts.	qrs.	lbs.	
3 hempen, of 21½ inches circumference	86	0	16	12 8 1
4 chain, of 2 inches diameter of links	192	0	0	38 8 0
				50 16 1
Weight of the anchors				14 0 ■
Total weight of the principal anchors and cables				64 16 1

MASTS AND YARDS.

		Length. Feet. in.	Diameter. Inches.	Weight. Tons. cwts. qrs.
Lower Masts	Main	83 7	37 ...	14 6 0
	Fore	77 ■	35 ...	10 18 0
	Mizen	67 ■	24 ...	5 1 2
	Bowsprit	45 6	36 ...	8 ■ 0
Lower Yards	Main	96 0	23 ...	4 4 0
	Fore	82 ■	20 ...	2 16 0
	Mizen, or cross-jack	64 0	15½ ...	1 2 0
Total weight of the masts and yards				46 15 2
Total weight of the ship, with stores and equipments, to a draught of water				Feet. in. Tons.
				Afore 20 0 } = 2200
				Aft 21 0 }
Weight of the hull, to a draught of water				Afore 13 6 } = 1308
				Aft 17 6½ }
Weight of the material received on board, in tons				892

FIFTH RATE. 42 guns. Tonnage, 1084 tons.

Complement of Men and Officers, 320 in number.

PRINCIPAL DIMENSIONS.

		Ft. in.
Length ■ the gun deck		151 9½
Length of the keel for tonnage		127 0½
Breadth, extreme		40 0¾
Depth in hold		12 ■

ARMAMENT.

	No. of guns.	Weight of each. Cwts.	Length. Ft. in.	Weight of each.		Total weight. Tons. cwts. qrs.
				Cwts.	Tons. cwts. qrs.	
Main deck	28 { 2 of 8 in.	... 50	7 0			
	26 32 pdrs.	... 39	7 6			
Quarter deck and forecastle	14 { 4 32 pdrs.	... 39	7 6			
	10 32 pdrs. carrds.	17	—			
Total weight of the guns						72 tons.
Total weight of the broadside in lbs. . . .						708 lbs.

	Weight of each. Cwts.	Total weight. Tons. cwts. qrs.
Weight of the principal anchors (4 in No.)	47 ...	9 8 0

WEIGHT OF THE PRINCIPAL CABLES.

	Weight of each. Cwts. qrs. lbs.	Total weight. Tons. cwts. qrs.
3 hempen, of 18½ inches circumference	■ 2 16	■ 11 0
3 chain, of 1¼ inch diameter of links	147 0 0	22 1 0
		31 12 ■
Weight of the anchors		9 8 0
Total weight of the principal anchors and cables		41 0 0

MASTS AND YARDS.

		Length. Feet. in.	Diameter. Inches.	Weight. Tons. cwt.s. qrs.
Lower Masts	Main	67 ■	30	8 0 0
	Fore	4	28	6 6 0
	Mizen	8	22½	■ 11 0
Lower Yards	Bowsprit	0	28	■ 0 0
	Main	78	19	2 11 ■
	Fore	67	16	1 18 ■
	Mizen, or cross-jack	55 0	13	0 15 0
Total weight of the masts and yards				27 1 0

Weight of the ship, with stores and equipments, to a draught of water	Afore	Feet. in.	Tons.
	Aft	19 4	= 1592
Weight of the hull, to a draught of water	Afore	10 6	= 760
	Aft	14 6	
Weight of the material received on board, in tons			832

SIXTH RATE. 26 guns. Tonnage, 913 tons.

Complement of Men and Officers, 240 in number.

PRINCIPAL DIMENSIONS.

Length ■ the gun deck		Ft. in.
Length of the keel for tonnage		105 ■
Breadth, extreme		40 7½
Depth in hold		11 6

ARMAMENT.

	No. of guns.	Weight of each. Cwts.	Length. Ft. in.
Main deck	18 { 2 of 8 ins. 16 32 pdrs.	... 50 ... 7 0 ... 40 ... 7 6	
Quarter deck and forecastle	■ { 2 32 pdrs. 6 32 pdrs.	... 40 ... 7 6 ... 25 ... 6 0	
Total weight of the guns		48 tons, 10 cwts.	
Total weight of the broadside in lbs.		452 lbs.	

	Weight of each. Cwts.	Total weight. Tons. cwt.s. qrs.
Weight of the principal anchors (4 in No.)	38	7 12 0

WEIGHT OF THE PRINCIPAL CABLES.

	Weight of each. Cwts. qrs.	Total weight. Tons. cwts. qrs.
2 hempen, of 17 inches circumference .	54 ■	5 ■ 0
3 chain, of 1 $\frac{1}{2}$ inch diameter of links .	126 ■	12 0 ■
		24 8 0
Weight of the anchors		7 12 ■
		—
Total weight of the principal anchors and cables . . .		32 ■ 0

MASTS AND YARDS.

	Length. Feet. in.	Diameter. Inches.	Weight. Tons. cwts. qrs.
Lower Masts	Main	■ 0	7 16 0
	Fore	■ 0	■ 0
	Mizen	53 6	■ 8 1
Lower Yards	Bowsprit	34 0	1 ■ ■
	Main	71 0	2 10 0
	Fore	61 0	1 14 0
	Mizen, or cross-jack	■ 0	0 14 ■
			—
Total weight of the masts and yards			22 10 3

	Feet. in.	Tons.
Total weight of the ship, with stores and equipments, to ■ draught of water	Afore 16 0 } Aft 17 0 }	= 960
Weight of the hull, to a draught of water	Afore 10 5 } Aft 14 4 }	= 510
		—
Weight of the material received on board, in tons		450

SLOOP, rigged as Ship. 18 guns. Tonnage, 462 tons.

Complement of Men, including Officers, 130 in number.

PRINCIPAL DIMENSIONS.

		Ft.	In.
Length between the perpendiculars		118	8
Length of the keel for tonnage		92	10 $\frac{1}{2}$
Breadth, extreme		30	7
Depth in hold	" 8 ■		

ARMAMENT.

	No. of guns.	Weight of each, Cwts.	Length. Ft. in.
Upper deck	18 { 2 32 pdrs. 16 ■ pdrs.	... 25 ... 6 0 ... 17 ... —	
Total weight of the guns		16 tons, ■ cwts.	
Weight of the broadside in lbs		■ lbs.	

	Weight of each.	Total weight.
	Cwts.	Tons. cwts. qrs.
Weight of the principal anchors (4 in No.) .	23	4 12 0

WEIGHT ■■■ PRINCIPAL CABLES.

	Weight of each.	Total weight.
	Cwts. qrs. lbs.	Tons. cwts. qrs. lbs.
1 hempen, of 14 inches circumference .	36 2 16	1 16 ■ 16
3 chain, of 1½ inch diameter of links .	90 3 0	13 12 1 ■
		—
		15 ■ ■ 16
Weight of the anchors		■ 12 0 0
		—
Total weight of the principal anchors and cables .	20 0 ■ 16	

MASTS.

Masts	Main	Length.	Diameter.	Weight.
		Feet. in.	Inches.	Tons. cwts. qrs.
	Fore	57 6	24 ...	8 10 0
	Mizen	52 6	22½ ...	2 15 0
	Bowsprit	47 6	18 ...	1 10 0
		■ 0	23½ ...	2 4 0
				—
	Total weight of the masts			9 19 0
	Total weight of the ship, with stores and equipments, to a draught of water	Afore	Feet. in.	Tons.
		Aft.	10 11 } = 480	

PART

Scantlings or Dimensions of the principal portions of Her Majesty's

	110 guns.	90 guns.	80 guns.
	Ft. in.	Ft. in.	Ft. in.
Length of the gun deck between the perpendiculares, from the aft side of the rabbet of the stem to the fore side of the rabbet of the stern post	204 0	207 4	190 ■
Length ■ the load water line, from the fore edge of the rabbet of the stem ■ the after edge of the rabbet of the stern post	203 0	208 0	189 0
Length between the perpendiculares from which the keel for tonnage is derived, viz., "from ■ perpendicular ■ the height of the upper deck at the fore part of the stem, to ■ perpendicular from the back of the post at the height of the gun deck lower sills".	207 6	210 2	192 3
Length of the keel for tonnage	166 5½	170 7½	155 3
Breadth, extreme, from outside to outside of wales	60 0	56 0	56 0
Breadth, extreme, for tonnage, or supposing the thickness of the plank of the bottom to be continued up	■ 2	55 ■	56 0
Breadth, moulded, or to the outside of the frame timbers	58 4	54 4	55 3
Breadth at the top timber line of dead flat ■ midship sections	45 0	47 0	44 0
Depth in hold, measured from the ■ edge of the upper side of the limber strake to the upper side of the lower deck beam	23 ■	■ 4	23 4
Burthen in tons	3099½	2761½	2589½
Gun deck ports, fore and aft	3 6	3 6	3 6
" " " deep	2 11	2 11	2 11
" " " sills from deck	■ 4	2 3	2 4
Middle deck ports, fore and aft	■ 5	.....	.....
" " " deep	2 11	.....	.....
" " " port sill from deck	1 11	.....	.....

XIX

Ships, usually termed SCHREWS or SCANTLIVES

SCHEMES OF SCANTLINGS—*continued*

	■ guns.	■ guns.	80 guns.
	Ft. in.	Ft. in.	Ft. in.
Upper deck ports, fore and aft	■ 5	■ ■	2 5
" " " deep	2 11	2 11	3 0
" " " port sill from deck	1 11	1 11	1 11
Quarter deck ports, fore and aft	3 1	3 0	3 1
" " " deep	2 8	2 8	2 8
" " " port sill from deck	1 7	1 8	1 7
Main keel, of elm.			
Square amidships	1 8	1 8	1 7
Fore end sided	1 ■	1 5	1 8½
After end sided	1 3	1 5	1 3
False keel, elm. Thick	No. 2 { 4 6	0 10	0 ■
Main keel, elm.			
Horizontal scarphs ■ be, long	4 9	4 9	4 6
Bolted with bolts of Diameter	0 1½	0 1½	0 1½
Main stem, English oak.			
To be moulded	1 ■	1 10	1 7
Sided at the head	2 2	1 8	1 7
Sided at the lower cheek	1 8	1 8	1 5
And to diminish at the junction with the keel to	1 6	1 5	1 3½
Apron, to be English oak.			
Sided at the head	2 3	1 8	0 11
Sided at the lower cheek	■ 8	.....	.....
Sided ■ the fore foot	1 ■	1 5	.....
And to be moulded as shown by the drawing for building	1 0	1 0	.....
Stern post, of English or African oak.			
Sided at upper end	2 1	1 10	1 10
Sided at the lower end, ■ the keel	1 3	1 5	1 3
Inner post. Fore and aft at the head	1 2	1 2	1 2
" " Fore and aft at the heel	1 8	1 ■	1 ■
Rising wood. In midships, thick	0 8	0 ■	0 6
" " " " broad	1 10	1 8	1 6
Height of cutting down in midships above the lower edge of the rabbet of the keel	2 10	2 10	2 10

Scantlings—continued.

Frigates, 50 guns.	Frigates, 38 guns.	Corvette, 18 guns.	sloop.	Screw steam sloop.	Schooner.	80 guns, screw.
Ft. in.	in.	Ft. in.			Ft. in.	Ft. in.
3 6	3 0	3 0	.....	.....	2 6	2 5
2 11	2 8	3 4	.....	.....	2 1	2 11
1 11	1 11	0 8	.....	.....	0 10	1 11
3 3	2 11	.....	.....	.....	.....	3 3
2 10	2 5	.....	.....	.....	.....	3 4
1 10	1 7	.....	.....	.....	.....	1 6
			Inches.	Inches.	Inches.	
1 6	1 4	12 by 15	14 by ■■■	14 by ■■■	10 by 12	1 8
1 2	.....	.....	12 by 16	11	8 by 12	1 4
1 2	.....	10½	12 by 16	14	8 by 12	1 4
2 No. { 6	{ 4 } .....	■	.....	.....	6	0 0
5 9	.....	.....	Ft. in.	Ft. in.	Ft. in.	0 0
0 1	.....	.....	5 0	4 9	3 0	0 1
.....	.....	.....	0 0½	0 0½	0 0½	0 1½
1 6	.....	1	1 4	1 3	.....	1 8
1 6	.....	.....	1 3	1 3	1 1	1 7
1 5	.....	15	.....	1 3	.....	1 7
1 2	.....	10½	1 0	0 11	0 8	1 ■
.....
.....
.....
1 6	.....	15½	1 3	1 5	0 11	1 8
1 2	.....	10	1 0	{ 1 5 2 0	0 8	1 3
1 1	.....	0 9	.....	0 10	0 7	.....
1 6	.....	1 3	.....	1 9	1 0	.....
0 1	.....	.....	.....	1 2	.....	.....
2 8	2 6	2 0	1 8	1 7	.....	2 0

SCHEME OF SCANTLINGS—*continued.*

	110 guns.	■ guns.	■ guns.
	Inches.	Inches.	Inches.
Floors. Sided	14 to 16	14 to 15	15 to 16
„ Moulded	16½	16¾	17
1st Futtocks. Sided	14 to 15½	14 to 15	14 to 15
„ Moulded	15	14	14½
To be coaked to the floor timbers, and bolted with square bolts of iron.			
Diameter	.....	½	⅜
2nd Futtocks. Sided	13½ to 14½	13½ to 14	13½ to 15
„ Moulded	14	13½	13¾
3rd Futtocks. Sided	13½ to 14½	13½	13½ to 14½
„ Moulded	13½	13½	13½
4th Futtocks. Sided	13 to 13½	12½ to 13	13 to 13½
„ Moulded	13½	13	12¾
5th Futtocks. Sided	13 to 13½	12 to 13	12½ to 13
„ Moulded	13½	13	12½
6th Futtocks. Sided	13 to 13½	11½	.....
„ Moulded	13½	11	.....
The other timbers to make up the required lengths to follow these proportions.			
Keelson. To be square	Ft. in. 1 8	Ft. in. 1 11	Ft. in. 1 6
Coaked or dowelled to the floors, or long and short-armed floors. Scarphs to be, long	5 6	5 6	5 6
Keelson bolts, in diameter	0 1½	0 1½	0 1½
„ „ „ number through each floor	0 1	0 1	0 1
Keelson side, to be coaked, and also bolted with bolts of . Diameter	0 1½	0 1½	0 1½
Keelson side Long .	.....	30 0	30 0
Stemson, to give shift to the scarphs of the stem and apron.			
To be sided	1 3	.....	.....
Moulded at the head	1 ■	1 2	.....
Moulded at the lower end	1 3	.....	.....
Bolted with bolts at the lower part, of Diameter	0 1½	0 1½	.....
At the head	0 1½	0 1½	.....
Bottom plank. To be thick	0 5	0 5	0 5
And this part, from 3 feet below the light water line upwards, to be of the very best quality of English oak.			

SCHEME OF SCANTLINGS—*continued.*

Frigates, 50 guns.	Frigates, 28 guns.	Corvette, 18 guns.	Steam sloop.	Screw steam sloop.	Schooner.	80 guns, screw.
Inches. 14 to 15 15½	Inches. 12 to 14 10½	Inches. 11 to 12 14 to 9	Inches. 10 to 12 13	Inches. 9 to 11 11	Ft. in. 0 8½ 0 6½	Inches. 15 to 16 16½
13 to 14 13	10½ to 11½ 9½	10½ to 11 8½	10 to 12 11½	9 to 11 9½	0 8½ 0 6½	15 to 16 15½
+	■	+	+
18 to 14 12	10 to 10½ 8½	10 to 9 8	9 to 10 10½	9 to 10 8½	0 8 0 ■	13½ to 15 14½
11½ to 12½ 11½	9½ to 10 7½	9½ to 9 7	9 to 10 9	8½ 7½	0 7½ 0 5½	13 to 14 14
11 to 11½ 10½	9½ to 10 7½	■ 7½	8 to 8½ 7½	8 7	.....	13 to 13½ 13½
10½ to 11 10½	9½ to 10 7	..... .....	8 6½	7½ 6	.....	13 to 13½ 13½
..... .....	..... .....	..... .....	..... .....	..... .....	.....	12½ to 13 12½
Ft. in. 1 3	14	1 1	Ft. in. 1 2	Ft. in. Deep, 0 10 1 2 Sided.	0 10	Ft. in. 1 8
5 6	.....	.....	5 6	.....	.....	■ ■
0 1½	.....	1½	0 1½	0 1½	.....	0 1½
0 1	.....	.....	0 1	0 1	.....	0 1
0 1½	.....	.....	Engine sleepers. 0 1½	0 1½	.....	.....
28 0	.....	.....	From 10 to 15 ft. beyond engine room, bulk.	.....	.....	.....
.....	.....	.....	.....	0 8	.....	1 4
.....
.....
0 5	4	3	0 4	0 3½	0 2½	0 5

Squares ■ Scantlings—continued.

		■ guns.	90 guns.	■ guns.
		Ft. in.	Ft. in.	Ft. in.
Main wales, English oak. Thick . . .		0 10	0 10	0 9
■ wales, English oak. Thick . . .		0 5½	.....	.....
Channel wales. Thick		0 5	0 5	0 ■
Sheer strakes, crown plank, of long lengths		0 4	0 4½	0 4½
Orlop shelf pieces. Broad		1 2	1 3	.....
■ ■ ■ Deep		1 0	0 9	.....
■ " " Bolts : Diameter		0 1½	0 1½	.....
Orlop beams. Moulded		1 3	1 2	1 ■
" " Sided		1 4	1 2	1 3
" " To round up		0 4	0 4	0 3½
Gun deck beams. Moulded		1 5	1 4	1 4½
" " " Sided		1 5	1 4	1 4½
" " " To round up		0 7	0 7	0 5½
" " " Flat, thick		0 4½	0 4½	0 4
Middle deck beams. Sided		1 3	.....	.....
■ " " Moulded		1 1	.....	.....
■ " " To round up		0 8	.....	.....
■ " " Flat, thick		0 4	.....	.....
Upper deck beams. Moulded		1 0	1 2	1 0½
" " " Sided		1 1	1 1	1 1½
" " " To round up		0 8	0 8	0 7½
■ " " Flat, thick		0 4	0 4	0 4
Quarter deck beams. Moulded		0 10	0 10	0 8
" " " Sided		0 11	0 10	0 9
" " " To round up		0 8½	0 8½	0 8½
" " " Flat, thick		0 4	0 4	0 3
Forecastle beams. Moulded		■ 8½	0 10	0 ■
" " " Sided		■ 9½	0 10	0 ■
" " " To round up		■ 8½	■ 8½	0 8½
" " " Flat, thick		■ 4	0 4	0 3
Round house beams. Moulded		■ 6½	0 ■	0 5½
" " " Sided		0 8	0 7½	0 7½
" " " To round up		■ 8	0 ■	0 8
" " " Flat, thick		■ 2½	0 2½	0 2½

SOME OF SCARCENESS—continued.

SCHEME ■ SCANTLINGS—continued.

		■ guns.	90 guns.	80 guns.
	Weight	Cwt. qr. lb.	Cwt. qr. lb.	Cwt. qr. lb.
<i>Weight of Iron Knees used to attach the Beams of the several Decks to the sides of the ship.</i>				
Orlop	Weight	3 0 14	3 0 0	2 3 0
Lower deck . . . . .	"	.....	.....	.....
Gun deck	"	3 2 21	3 2 10	3 1 ■
Middle deck	"	2 3 14	.....	.....
Upper deck	"	2 0 3	2 2 10	2 0 0
Quarter deck and forecastle	"	1 1 22	1 2 0	1 1 ■
<i>Fore step, to be made by two crutches.</i>				
Sided		Ft. in.	Ft. in.	Ft. in.
Asunder in the clear		1 1	1 0	1 1
Long		4 0	3 6	3 6
Bolted with 10 bolts, of	Diameter	13 to 14 ft.	14 0	14 0
Main step. Sided		0 1 $\frac{1}{2}$	1 $\frac{1}{2}$ to 1 $\frac{3}{4}$ in.	0 1 $\frac{1}{2}$
" Deep ■ the keelson		3 8	3 0	3 0
Length such ■ will allow it to pass clear of the well stanchions.		2 4	1 6	1 6
Mizen step. Sided		2 0	1 10	1 10
" Deep . . . . .		.....	.....	.....
" Bolted with bolts. Diam.		0 1 $\frac{1}{2}$	0 1 $\frac{1}{2}$	0 1 $\frac{1}{2}$
Riding bitts. Fore pair, square		1 10	1 7	.....
" " After pair, square		1 11	1 8	1 8
" " Above the deck		■ 1	4 10	4 10
<i>Cross pieces to riding bitts.</i>				
Fore and aft way		1 8	1 6	1 6
Deep		1 7	1 4	1 4
<i>Main geer and topsail sheet bitts.</i>				
To be of African timber, and square		1 2	1 2	1 1
Main-mast partners. Deep		1 6	1 5	1 5
" " Broad		1 5	1 4	1 4
" " Above the beam		0 8	0 8	0 8
Gun deck, breast hook. Sided		1 3	1 2	1 2
" " Long		18 0	.....	18 0
Bolted with bolts of	Diameter	■ 1 $\frac{1}{2}$	■ 1 $\frac{1}{2}$	0 1 $\frac{1}{2}$
Gun deck clamps. Thick		0 9	0 8	0 8
Gun deck shelf. Broad		1 4	1 3	1 4
" " Deep		1 4	0 10	1 2
Bolted with bolts of	Diameter	0 1 $\frac{1}{2}$	0 1 $\frac{1}{2}$	0 1 $\frac{1}{2}$
Gun deck spirketting. Thick		0 6 $\frac{1}{2}$	0 7	0 7

SCHEMII.—SCANTLINGS—*continued.*

SCANTLINES—continued.

		110 guns.	90 guns.	80 guns.
		Ft. in.	Ft. in.	Ft. in.
Gun deck waterways.	Sided	0 11	0 11	0 11
" "	Deep	1 2½	1 1	1 2½
Middle deck shelf.	Broad	1 3	.....	.....
" " "	Deep	1 0	.....	.....
" " "	Bolts . Diameter	0 1½	.....	.....
Middle deck waterway.	Sided	0 10½	.....	.....
" " "	Deep	1 2½	.....	.....
Middle deck spirketting.	Thick	0 5½	.....	.....
Upper deck, deck hook.	Sided	1 2	1 0	1 1
" " "	Bolts Diameter	0 1½	0 1½	0 1½
Upper deck shelf.	Broad	1 2	1 0	1 ■
" " "	Deep	1 0	0 8	0 10
" " "	Bolts . Diameter	0 1½	■ 1½	0 1½
Upper deck waterway.	Moulded	0 10	0 10	0 10
" " "	Deep	1 2	1 0	1 1½
Upper deck spirketting.	Thick	0 5	0 5	0 5
Quarter deck clamps.	Thick	0 ■	0 4	.....
Quarter deck shelf.	Broad	1 0	1 0	1 2
" " "	Deep	■ ■	0 7½	0 8
" " "	Bolts . Diameter	0 1	0 1	0 1
Quarter deck waterways.	Moulded	0 ■	0 9	■ 9½
" " "	Deep	0 11	0 10	0 11
Quarter deck spirketting.	Thick	0 3	0 4	0 3½
Cat heads.	Fore and aft	1 8	1 7½	1 7
" " "	Deep	1 6	1 5	1 5
Rudder head, to be in diameter	■ 3	■ 3	2 3	
Iron riders in the hold.	Broad	0 ■	0 ■	0 8
" " "	Thick	0 1½	0 1½	■ 1½
" " "	Bolts Diam.	0 1½	■ 1½	0 1½

SCHEME OF SCAFFOLDING—*continued.*

Frigates, 50 guns.	Frigates, 28 guns.	Corvette, 18 guns.	Steam sloop.	Screw steam sloop.	Schooner.	60 gun screw.
Ft. in.	Ft. in.	Ft. in.	Ft. in.	Ft. in.	in.	
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
1 0½	.....	.....	.....	.....	0 7	....
0 1¼	.....	.....	.....	.....	0 0½	....
1 4	.....	1 1	.....	.....	.....	....
1 0	.....	0 9	.....	.....	.....	....
0 1½	.....	0 1	.....	.....	.....	....
0 11	1 1	1 1	.....	.....	.....	....
1 2	■ 9	0 ■	.....	.....	.....	....
■ 1	.....	.....	.....	.....	.....	....
■ 4	.....	.....	.....	0 5	.....	....
1 2	0 10	.....	.....	0 10½	.....	....
0 9	0 ■	.....	.....	0 7½	.....	....
0 1½	0 0½	.....	.....	0 0½	.....	....
0 9	1 ■	.....	.....	.....	.....	....
1 0	0 7	.....	.....	.....	.....	....
0 8½	0 3½	.....	.....	.....	.....	....
1 ■	1 3	1 2	.....	.....	.....	....
1 ■	1 2	1 1½	.....	.....	.....	....
2 0	1 ■	1 4	1 8	.....	.....	....
0 6	0 4½	0 4½	■ 4½	.....	.....	....
0 1½	0 0½	■ 0½	■ 0½	.....	.....	....
0 1½	0 0½	■ 0½	■ 0½	.....	.....	....

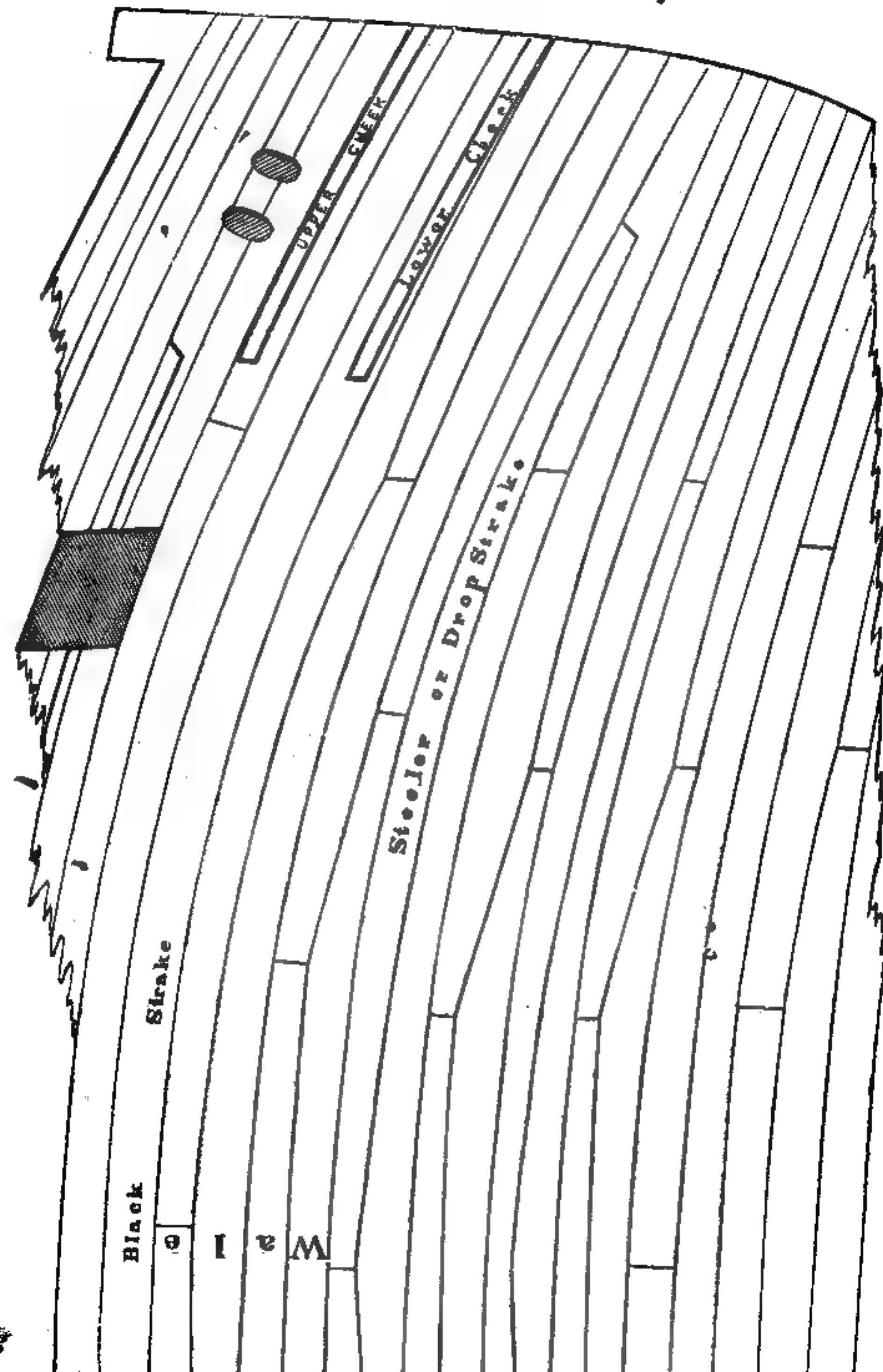
PART XX.

Method of expanding (by —— of the Sheer Drawing — Draught) the Bottom of a Ship — Paper, or — Delineation of the whole Surface of the outside of the Timbers that compose the Frame of her; — mechanical operation that enables the practical ship builder to arrange a disposition of the plank and thickstuff — — covering to the timbers of the ship under the breadths, lengths, and positions that will be the most advantageous for strength to the ship and economy in the conversion of the store of planking.

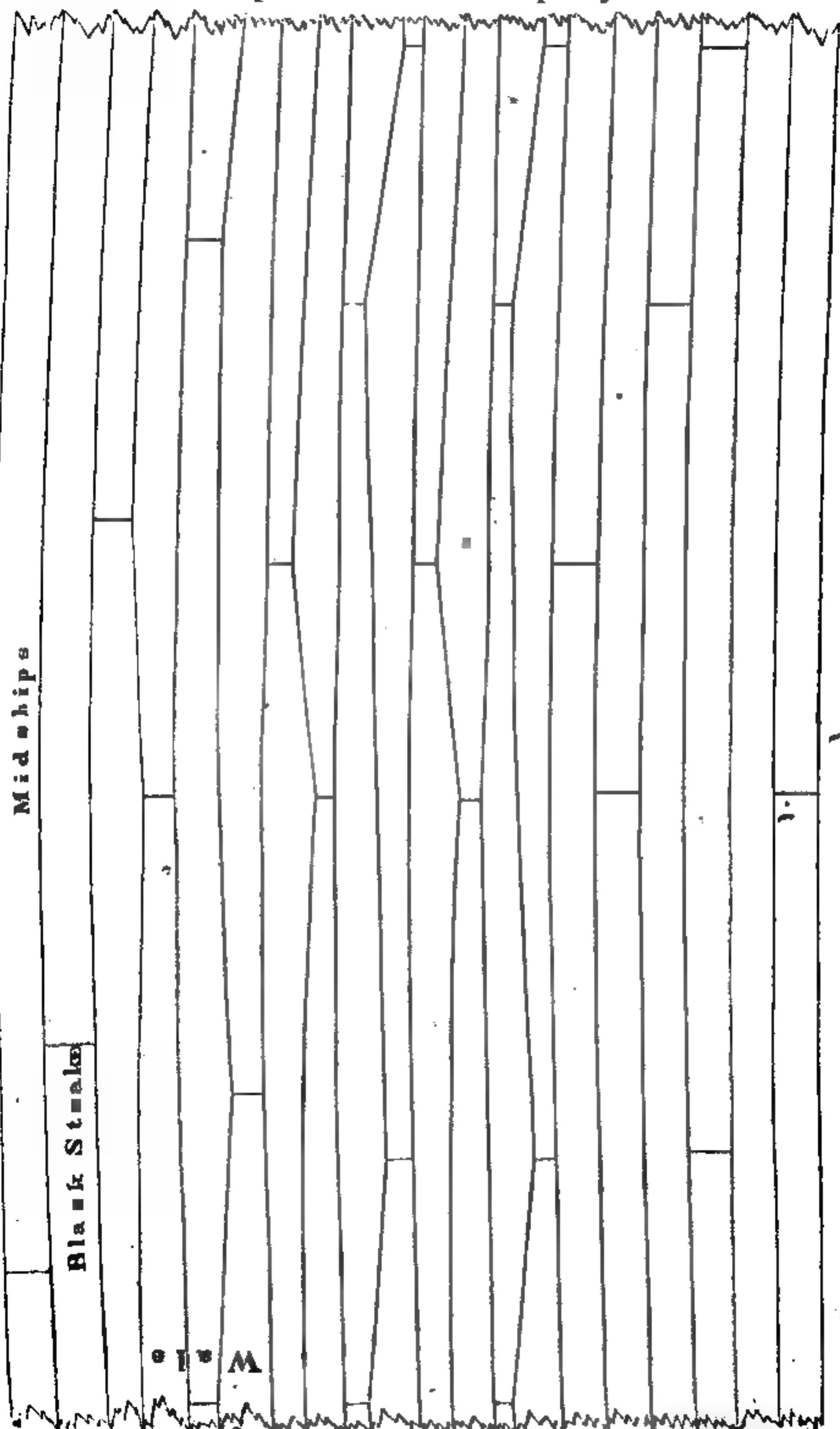
THE expansion of the outer surface of the timbers of the frames being attended with — trouble, and requiring a little more attention than the other ordinary duties of the draughtsman, it may be thought by some that such a delineation of the planking might be dispensed with, without its being detrimental to the process of planking or skinning the bottom of the ship. True it is that the ship builder may, with the quick eye that long practice has given to him, determine at a glance the positions of the least girt of the body from the keel to the wales in the fore and after portions of the ship, and by girting the frame of the vessel at these places ascertain the contraction or extension of the breadths of the bottom plank that may be necessary to make it fit to the timbers or ribs under the most advantageous form. But the surface presented by the bottom of a large ship is a wide field for the human eye to travel over and fix on it the station of each butt or end of the numerous planks composing the skin or covering of the timbers, besides having at the same time to bear in mind also, that they have reference to the arrangements of the internal portions of the planking; and thence time will be saved and a more perfect floating structure be built, if the following method be adopted (even under a rough guise) to describe, by lines on paper, the edges of the wales, diminishing plank, and plank of the bottom.

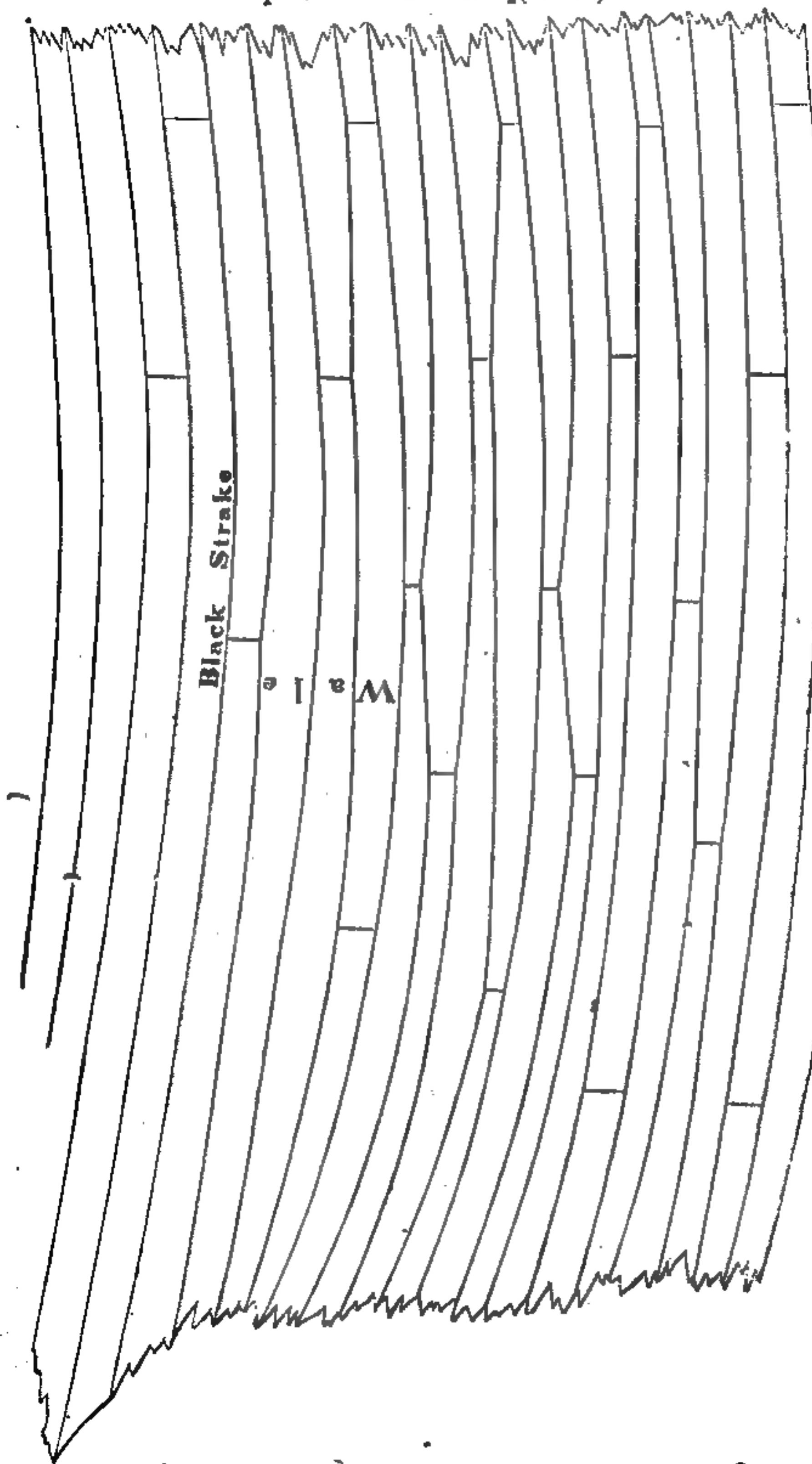
The required expansion is obtained from the sheer drawing of the ship (Plate 1), with the aid of a midship section of her (Plate 2), on which the draughtsman has shown the sectional

Sketch I.
Expansion of Plank outside. Fore Body.



Sketch 2.
Expansion of Plank. Midship Body.



*Sketch 3.*Expansion of After Plank^s(outside).

— of the different strakes of wale, diminishing plank, and plank of the bottom.

The base line of the expansion is assumed ■■■ representation of the middle of the rabbet of the keel, or the lower boundary of the surface of the timbers of the frame, of which surface the proposed expansion is ■ development (Sketch 2, of Expansion, p. 122).

This base line will be necessarily ■ straight line, the keel partaking of no part of the form of the body of the ship; therefore from the sheer draught (Plate 1) take the stations of the frames as shown on that drawing by straight lines at equal distances apart, and transfer them to the straight line, assumed ■ the base line, to represent the middle line of the rabbet of the keel, the after end of such line being governed in length by the after edge of the rabbet of the post at the height of the middle of the rabbet of the keel; and the fore end running as far forward ■ the form given to the ship forward, makes the middle line of the rabbet of the keel a straight line.

The heights (Plate 1) on the sheer draught of the ship from the line representative of the middle of the rabbet of the keel to the lines descriptive of the edges of the several portions of the planking, would be projected heights, or, artistically speaking, fore-shortened heights; but the expansion requires that the shortened height should be extended to its whole length as an ordinate of the surface of which it is ■ part; and to obtain such, the length must be taken round the section of the frame on the body Plan, or what is termed the girt, to the point on the section which is descriptive of the line of wales, diminishing plank, or plank of the bottom (as shown in Sketch 2, of Expansion, p. 122).

The midship frame and its planking, under these circumstances, is first expanded in height, which is done by penning ■ thin batten round the midship section (Plate 2), and marking on it the middle of the rabbet of the keel and the points denoting the edges of the wales (as n), sheer strakes,

upper and lower sides of ports, &c.; and this batten being allowed to fly straight, is applied to the straight line, which is assumed to be representative of the midship section in the sheer plan. The mark on the batten, which was made to denote the relative position of the middle line of the rabbet of the keel, being kept well with the base line before described, and the batten lying square to that base line, the expanded heights, from the middle line of the rabbet of the keel to the several portions of the planking, viz., wales, ports, &c., are transferred from the batten to the paper.

The heights of the wales, ports, and sheer strakes, &c., are determined by the draughtsman on the sheer drawing (Plate 1), are next to be transferred from the sheer plan to the body plan; and these are again, by their breadths, thus obtained on the body plan, to be run off or developed for length on the half-breadth plan (as shown in Plate 1), curves, which in the half-breadth plan are descriptive of the wales, port, sill lines, sheer strakes, &c., through the length of the ship. Pen bend thin battens round these curves, and mark on each batten the points where these lines severally cross the line denoting the midship section of the half-breadth plan, and also where each timber, denoted by a straight line, crosses the curves, viz., those that, in the half-breadth plan, severally point out the line of the wales, sheer strakes, water lines, &c., thus giving the girts of these points from the midship section each way. This will give for length, the ordinates of the expansion which are due to the several points of the wales, sheer strakes, water lines, &c. For height, in a similar manner pen battens to the girts of the other sections in the fore and after bodies of the body Plan, from the middle of the rabbet of the keel, and mark on them the positions of the upper and lower edges of wales, sheer strakes, height of water lines, and decks at the side, &c.

Under these considerations, for each point of these lines there are two expanded dimensions obtained, one for height and the other for length; and the two are capable of being

set off, from common standards: for length from the midship section, each way; for height, from the base line, assumed as the middle line of the rabbet of the keel; but the expansion, being a surface, admits but of two dimensions for each point, and thence each point of the planking can be determined by the method that has been given, and the full inner surface of the planking be depicted; and the doing so will allow the practical builder to arrange the butts of his planking on paper on his drawing board. A rough block model will greatly assist the expansion drawing, ■■■ batten can be penned on it, and the best positions for the planking be determined by it.

REFERENCES TO THE SKETCHES OF THE EXPANSION OF ■■■
FORE, MIDSCHIP, AND AFTER BODIES FOR ■■■ PLANKING OF
THE OUTSIDE OF A SHIP.

These three would form in practice ■■■ expansion, the restricted size of the plates of this rudimentary work requiring the division that has been made into fore, midship, and after bodies.

On the fore body expansion (Sketch I, p. 121), made ■■■ described by the text, the position of the hawse holes, bow port, cheeks of the head, &c., are marked. The cheeks are placed in the centre, or nearly so, of ■■■ plank, that the planks may be caulked or made water-tight in their seams or joints without the cheeks being removed or unbolted, ■■■ operation that would be attended with ■■■ expense and loss of time. The butts are also shown, with three planks between them.

The several methods of working the planks, under the conversions styled top, and butt and fair edged, are also shown; and ■■■ steeler, to take out the sny of the plank, is also delineated.

This description of the fore body expansion will serve to elucidate the terms for the form of plank shown on the midship and after body expansions.

PART XXI.

Description of the Fittings to the Riding ■ Mooring Bits.—Common—
Elliot's.—Description or Reference to Plate 5.—Deck Hook, how formed.
Iron Crutches.—Iron Breast Hooks.—Cleats, their form and uses.

Sketch 4.

Sketch of the Riding or Mooring Bits, ■ fitted in Her Majesty's Ships of War.

Elliot's Bits.

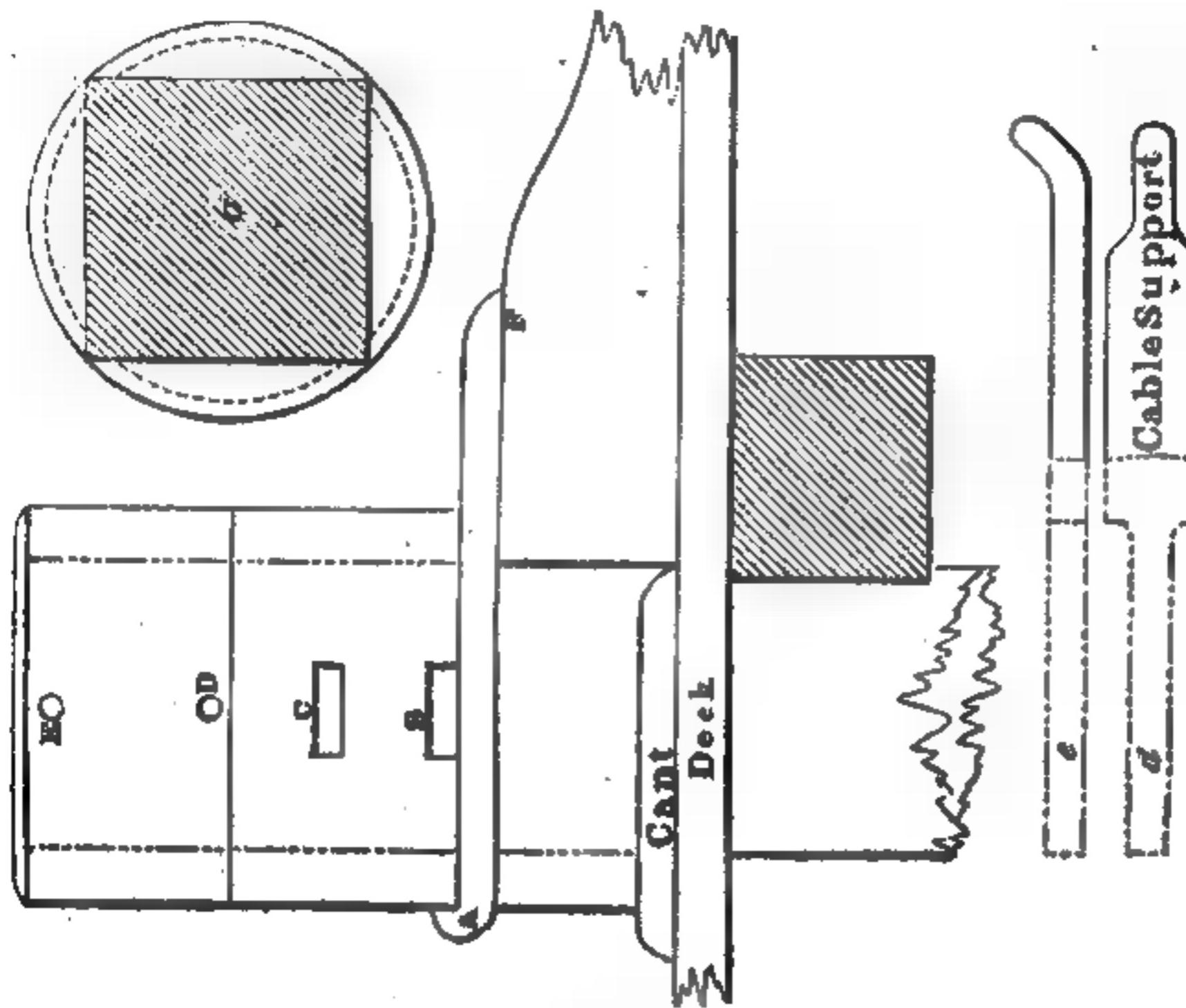


Fig. 3.

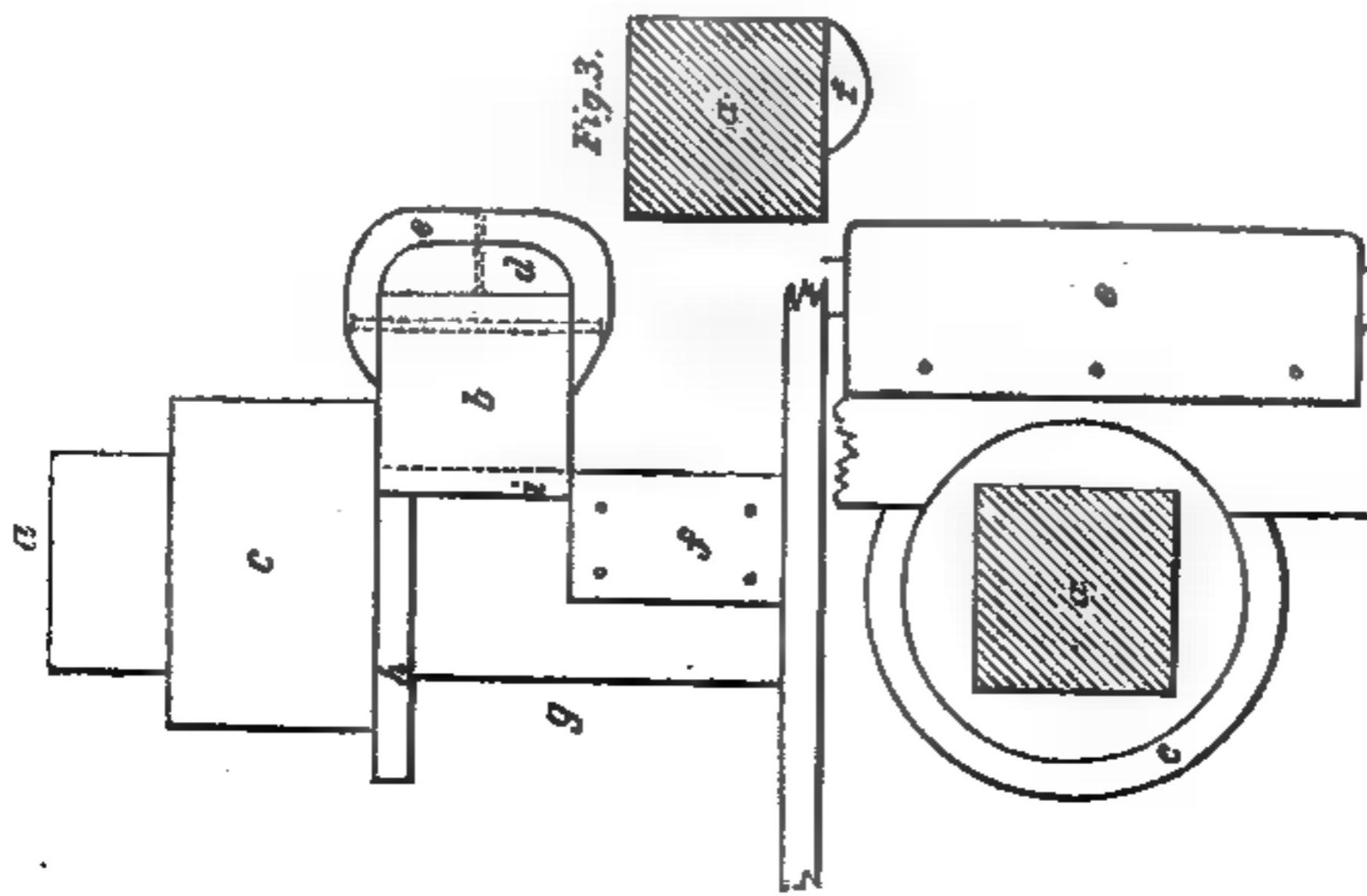


Fig. 1.

Fig. 2.

DESCRIPTION OF ■■■■■ 4.

Sectional elevations and plans of riding bitts: the ■■■■■ as commonly fitted in ships of war, the other ■■■■■ fitted on a design suggested by Admiral Elliot, of the British Navy, to be practised where want of room on the deck or platform for the training of the guns makes it expedient that ■■■■■ portion of the common method of fitting, viz., the cross-piece, should be dispensed with. The methods of arming both descriptions of mooring bitts with iron ■■■■■ also shown, such fortifications being necessary to protect the mooring bitts when chain ■■■■■ iron cables are used; but these fittings are ■■■■■ adapted, that the hempen or rope cables may be worked round them without injury to the cables.

REFERENCES TO ■■■■■ SKETCH.

Figs. 1 and 2, Riding Bits on the common plan, having a cross-piece (b).

- a, A sectional elevation of the riding bitt above the deck (A). The section (a) being drawn on ■■■■■ scale, is descriptive of the size of the bitt, which, in the first-rate ■■■■■ of war, is 1 foot 10 inches. They are usually of oak.
- b, Sectional elevation of the cross-piece to the bitt (a), which, in size, for the first-rate, is 1 foot 8 inches in the fore and aft direction, and 1 foot 7 inches deep. (*Vide* the appended scheme of scantlings for ships.) The cross-piece (b), which is of oak, extends ■■■■■ each pair of riding bitts, and the ends of it project beyond them, thus tying the bitts together and forming a larger surface to wind the cable round, by which means the friction is increased and the security for the cable made more firm. The cross-piece is made to clasp the corresponding riding bitts of each side (or the two fore ■■■■■ two after ones) by what is termed ■■■■■ facing ■■■■■ scoring over them (i, fig. 1).
- c, An iron casting ■■■■■ iron hood, which is hollow, and fitted over the square of the bitt head as shown in the plan (fig. 2), by the corresponding letter (a), in which sectional plan the thickness of the iron in the hood (c) of fig. 1 is depicted by the distance between the concentric circles containing the distinguishing letters (c). This casting has a flanch ■■■■■ projection cast to it (k), which forms a shelf, ■■■■■ it might be termed, for the turn of the cable round the bitt, to rest on; and (d), face piece of elm used to ■■■■■ the cross-pieces (b).
- e, A casting of iron employed ■■■■■ a shield to the cross-piece (b) and face piece (d), to preserve them from the ■■■■■ friction which arises from the iron cable running over them when the cable ■■■■■ bitted for stopping the motion of the ship after the anchor is let go, which motion has to be checked by the cable being compressed and allowed to slip gradually round the bitt (a) and cross-piece (b).
- f, Arming of casting iron to protect the side of the bitt (a) below the cross-piece

- (b) from the rub or chase of the iron cable. The plan section of *f* is shown in fig. 3, where ■■ a plan section of the bitt, and *f* the same of the iron casting (*f*) of fig. 1.
g, At *g* a wooden knee ■■ standard to the bitt (*a*) is worked to support the heavy strain brought on^{*} the bitt (*a*). The bitt (*a*) usually runs down through two decks, but is not secured by a standard on the lower ■■

REFERENCES TO ■■ SECTIONAL ELEVATION AND PLAN OF ■■ RIDING BITTS ■■ ■■ WITHOUT A CROSS-PIECE, OR WHEN ■■ ON A PLAN SUGGESTED ■■ ADMIRAL ELLIOT, ■■ ■■ MAJESTY'S NAVY.

A, Worm ■■ thread ■■ in the under iron hood (*b*), forming the lower separation between the turns of the chain cable, two or three of which turns ■■ usually taken round the bitt head when they ■■ thus fitted.

a, Plan section of the bitt head, with the iron hood (*b*) round it.

B & C, Mortices ■■ holes cut through the lower hood (*b*) to receive the cable supports to keep the other turns of the cable separate. The cable supports which ■■ inserted in these mortices are described in the figure, both in plan and elevation, by sections, that of plan being marked *c*, and the elevation *d*.

D & E, Holes through the upper casting (*c*), to receive round bolts to prevent the upper turns of the cable from flying off over the bitt head when the cable is veered out for anchoring the ship.

F, Standard or wood knee to the riding bitt, to which the flange of the lower hood (*b*) is secured ; but the standard (*F*) is principally designed to support the riding bitt and resist the strain brought ■■ it. The standard to be, in height from the deck, about twice the diameter of the hempen cable.

The riding or mooring bitts ■■ this principle are not required to be so high above the deck ■■ to which they ■■ placed ■■ those fitted with a cross-piece ; and although ■■ faulty construction in the deck plan of a ship, in its not affording space for the required evolutions of the foremost guns of the battery without the removal of the cross-piece to the riding bitts, may make the bitt without ■■ cross-piece to be a fitting that may be tolerated in practice : still, the twisting strain brought on the bitt head when the cable is veered round it has ■■ great tendency (from the bitt head being unaided by the cross-piece, and isolated, as it were, from any support from the other bitt) to destroy the bitt by wrenching it out of its place. In ■■ instances, when thus fitted in the navy, such an occurrence to the riding bitts took place, and the evil was in ■■ measure rectified in the subsequent fittings on this plan by deep carlings, or as it were shores, being worked athwartships between the two bitts. This plan would soon be obsolete if the deck plan of the naval construction ■■ made with due regard to the requirements of the naval artillerist for working and training the guns.

DESCRIPTION OF PLATE 5.

Deck Hook, descriptive of the portion of the Frame of the Ship alluded to at page 55.

Fig. 1. The [redacted] marked *a* [redacted] of wood, and [redacted] called ekings. They are in-depth the same thickness as the moulding of the beams, and [redacted] scarphed together at the middle as shown by the fig. An iron hook is then worked over them in thickness [redacted] described in the fig., of the breadth of 5 [redacted] 8 inches, and the whole, [redacted] the wood ekings and the iron hook, bolted firmly to the timbers and plank of the ship [redacted] shown in the sketch, the bolts (*b*) decreasing in diameter from those shown at the scarph of the ekings to the outer arms. The bolts in the throat of the iron hook, in a large ship, [redacted] usually 1½-inches bolts; and at the ends of the [redacted] [redacted] of an inch in diameter.

b & c, Figs. 1 and 3. Iron crutches or staples, marked *a*, used internally to tie the two sides of the ship together in the after extreme of the vessel, the centres of them, [redacted] *b* and *c*, being on the upper sides of the after dead-wood, and the [redacted] laying across the heels of the timbers, [redacted] that the bolts shown in the sketch [redacted] each in separate timbers.

A & B, Figs. 4 and 5. Iron breast hooks, performing the [redacted] office in the fore extreme of the ship that the iron crutches do in the after extreme, and they are placed between the deck hooks.

Cleats or Mechanical Contrivances for the reception of the Heads and Heels of the Shores which are employed in putting together the Frames of a Ship, and those used in the several portions of her planking and of her general construction.

a, Wale cleat, or one of those which [redacted] placed [redacted] the wales after the planks so denominated [redacted] worked. The cleats are secured to them, in the Queen's service, by Mr. Blake's screws, and in the merchant service by large nails, driven on a ring to insure their removal when they [redacted] no longer required. The nails used [redacted] called spike nails. The upper [redacted] or notch of this cleat is intended to receive the head of a shore, called a wale-shore, which is placed with its head above the level, the heel [redacted] outer end being brought to the standards or uprights which usually surround building slips. These shores preserve the form while building by preventing the sides of the ship from falling outwards. The lower score receives the head of a shore, the heel of which is down on the groundways of the slip, and which heel is kept in its position by a cleat (*b*), also secured with Blake's [redacted] or nails. These shores take, in part, the weight of the ship.

c & d are cleats in working plank, to make stops abutments for wedges against.

Fig. 8. A piece of timber with mould laying on it, showing the connection when chocks used instead of square heads and heels in the frame.

On the Plate 5, fig. 9, is shown a method sometimes used to ~~raise~~ the bag of the frame of timber, — the curved portion of it, — being hoisted into its place, over the floor ribband shown in the plate in the half section, fig. 6, the floor head being distinguished by the letters c d, and the floor being depicted therein crossed over the keel. On the frame to be hoisted are marked, in its several parts, the abbreviations used to denote the several heads and heels of the timbers, viz. F. H. for floor head, 1 H. for first head, &c. Cleats of the description marked C, in this plate, are nailed to the frame in the positions pointed out by the shaded sections of wedges placed inside of it. Between these a board is placed, described by e, which acts as a shore, and prevents the upper and lower parts of the frame from coming together when it is being raised, and forms a ladder for the workmen to ascend the frame and fix the cross paul, or what may be termed a tie, to keep the frame to its proper spread — width athwartships. On this section will also be found the positions of the several ribbands, as marked 1st S. R., &c., which is an abbreviation of the 1st sirmark ribband. A rope or chain is, as an additional security, wound round the frame and shore at the middle of e, and taut by wedges on e.

PART XXII.

Description of the several Modes used in Her Majesty's service for uniting the Beams in the sides of the Ship.—References to Plate 8, — descriptive Drawing of a Compressor for the Chain Cables.

DESCRIPTION OF SECTIONS OF KNEES TO BEAMS, AS SHOWN IN PLATE 6.

Scale, 1 of an inch to a foot.

Fig. 1.—Iron plate knee, in Mr. Roberts's plan, with the waved arm to the beam arm, — described in fig. 3, Plate 7.

Fig. 2.—Plate knee of iron, used by Mr. Roberts for connecting the chocks worked to receive the plate knees of the lower deck of line-of-battle ships, with the other bottoms of the frames.

*Fig. 3.—Front view of the beam arm of a knee, introduced by Mr. Lang, Master Shipwright of Woolwich Yard, in building the *Royal Albert*, of 120 guns. The knee, running down from the lower deck beam, passes the orlop deck, ■ shown in the fig.*

Fig. 4.—The front view of the side arm of the ■ knee, with the position of the bolts. These knees have ■ great tendency to render the fabric firm, the knee performing the double office of a knee and a brace.

Fig. 5.—Section of ■ horn knee, with three bolts in the horn which clasps the beam.

Fig. 6.—Iron plate knee used by Mr. Roberts, with the intervention of ■ chock, to unite the orlop beams to the side of the ship.

Fig. 7.—Plate knee of fig. 3, plate 7, without the chock, the description of which is there given.

DESCRIPTION OF THE SECTIONS OF IRON KNEES TO BEAMS, AS SHOWN IN PLATE 7.

Scale, $\frac{1}{2}$ of an inch to a foot.

Fig. 1.—The section of an iron knee, for the security of the beam ends to the side of the ship, introduced into the practical carpentry of the British navy by Sir William Symonds, late surveyor of Her Majesty's navy. The section shows the thickness of the iron in the side and beam ■ of the knee, which are worked to the internal planking, with the breadth of iron of the horn or clasp of the knee to the beam.

Fig. 2.—Front view of the same knee, drawn with ■ cast or ■ diagonal direction given to the side arm; being the form of iron knee that is used where the beams of one deck are adjacent to the ports on the other. The section gives the breadth of the side ■ of the knee and the thickness of the horn that clasps the beam. The upper bolts, ■ those in the throat ■ thickest portion of the knee, are, in large ships $1\frac{1}{2}$ inches in diameter, the lower ones, or those in the extreme ends of the knees, being $\frac{3}{4}$ of an inch in diameter. The intermediate bolts in both side and beam arms being graduated in size between these limits of $1\frac{1}{2}$ inches and $\frac{3}{4}$ of ■ inch, the fib or turned-up portion of the beam ■ of the knee (shown in fig. 1) is let up into the beam before the iron knee is bolted.

Fig. 3.—Side section of ■ beam, and a chock worked to receive ■ iron plate knee, introduced by Mr. Roberts, many years master shipwright in Her Majesty's service. The objection made to the ■ of this security of the beam end to the side of the ship is this: that the bolts in the beam arm, from being all in one range of the fibres of the wood, have ■ great tendency to split the beam end. The projector, Mr. Roberts, to overcome this

serious objection, made the upper arms of these plate knees in a waved form, vide fig. 1, Plate 6, which in some measure obviated the objection by keeping the bolts from being in a range at the beam end.

Fig. 4.—Front view of the check under the beam, with the plate knees let into the chock, their thickness $1\frac{1}{2}$ inches; and descriptive also of the ends of the plate knees next the side of the ship being turned round to lay against the side of the ship, and to take two bolts through them.

Fig. 5.—Iron knee used for the security for the beam ends of the poop of a line-of-battle ship. It is usually denominated a dog plate. The upper part of the knee is formed by a round bolt, long enough to pass through the beam, as shown by the figure, the bolt being clenched in an iron ring or plate upon the upper side of it. The bolts in the side arm (A) pass through the shelf and side of the ship.

Fig. 6.—Usual hanging knee of iron, used for the lower deck beams of frigates, orlop and quarter deck beams of line-of-battle ships. The section is descriptive of the thickness of the knee at the several parts of it, and gives the positions and size of the bolts in each arm of it.

Fig. 7.—Front view of the up and down part of the knee (fig. 6). This knee is worked home to the internal planking without the intervention of chocks, as in the knee described in fig. 4. By this arrangement the length of the bolts is decreased, which reduces the expense of materials and the weight of the hull of the ship; the shrinkage of the chocks is avoided, and the work, from these considerations, is stronger and more economical.

Fig. 8.—Iron knee for the security of the upper deck beams of line-of-battle ships, of which fig. 12 is the front view of the side arm; also showing the horn clutch of it to the beam. The bolts are also depicted. The rule is used for the diameter of the bolts as given for the lower deck knees.

Fig. 9.—Side section of the plate bolt (fig. 5). This gives the thickness of the plate iron, and the position of the bolts.

Fig. 10.—Horn knee, introduced by Sir Robert Seppings, for the security of the lower deck beams of line-of-battle ships. The dowels in the beam and shelf are shown in it, and the bolts through the horn and beam.

Fig. 11.—Section of fig. 10, giving the thickness of the side of it, and the breadth of the horn which clasps the beam, and the stations of the bolts for securing it.

PLATE 8,

Or a Description of the Elevation and Plan of a Compressor or Stopper used in Her Majesty's Ships for checking the Chain Cable when running out round the Riding Bits after the Anchor has been let go.

Scale, 1 inch to a foot.

ELEVATION. FIG. (1).

- a, Section of iron pipes forming a tube for the cable to run through, the links of the cable being shown in it.
- b, A chock let down through the deck (c) to the beams, described by the sections d, d.
- c, Deck a platform on beams.
- d, d, Beams to receive deck or platform.
- g, Compressor of iron or bent lever pivoting on the bolt f, and which, by the use of a tackle on the end, is made to force or compress the chain cable against the pipe and beam, and thus increase the friction on the riding bits and cross-piece. The chain cable was found under such a fitting to force down the compressor and the bolt (f) which led to the introduction of the strap (e) bolted to the beams (d, d).
- m, Carlings of wood let down between the beams (d d) to form a bed for the iron pipes, a.

Fig. 2, Plate 8.

References to the Plan of the Compressor, which Plan is supposed to represent the underside of the Deck and Beams.

- a, Pipe or tube for the chain cable, which in men-of-war is governed in diameter, by being in size $\frac{3}{4}$ of the diameter of the hawse pipe in the clear.
- d d, Undersides of the beams.
- g, A section of the compressor showing the form of it.
- k, Head of the bolt (f of elevation) on which the compressor revolves.
- h, A fan or counterbalancing worked in the compressor to assist the staple marked in keeping the compressor in its place.
- i, An iron plate screwed on to the underside of the beam, to form a hard surface for the fan (h) to work upon.
- e, Strap to support the compressor (g).

This plan for the compressor, which was introduced into her Majesty's ships when iron cables first came into use, owed its invention to Captain Chas. [redacted] of the British navy; the additions, viz., the fan (h) and strap (e), practice suggested, and, with these improvements, it is preferred to the

PART XXIII.

The Mechanical Power employed ■■■■■ raise the Anchor.—Methods used for uniting the Cable with the Capstan.—The Fittings of the Capstan should be well tested.—Power Capstan attained by Machinery not advisable for ■■■■■ Man-of-War.—Plate of Common Capstan, or ■■■■■ which ■■■■■ Messenger ■■■■■ used.—References to the Plate.—Plate of Brown's patent Capstan, to which the Cable is brought without the intervention of ■■■■■ Messenger.—References to the Plate.—Windlass.

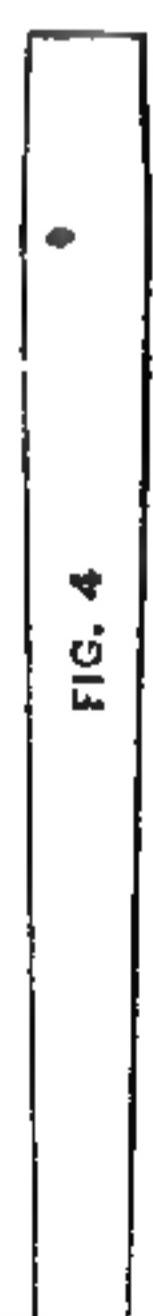
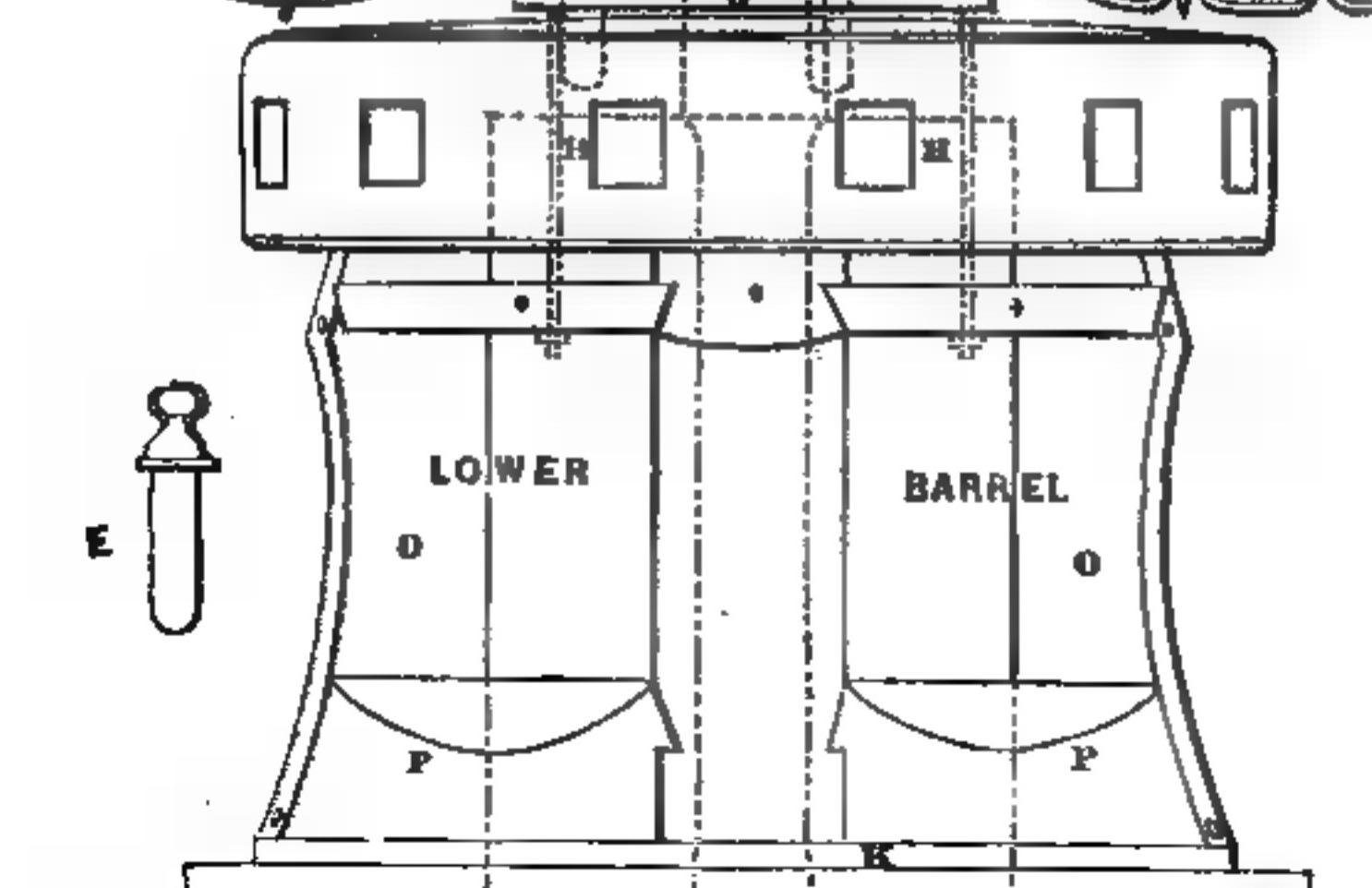
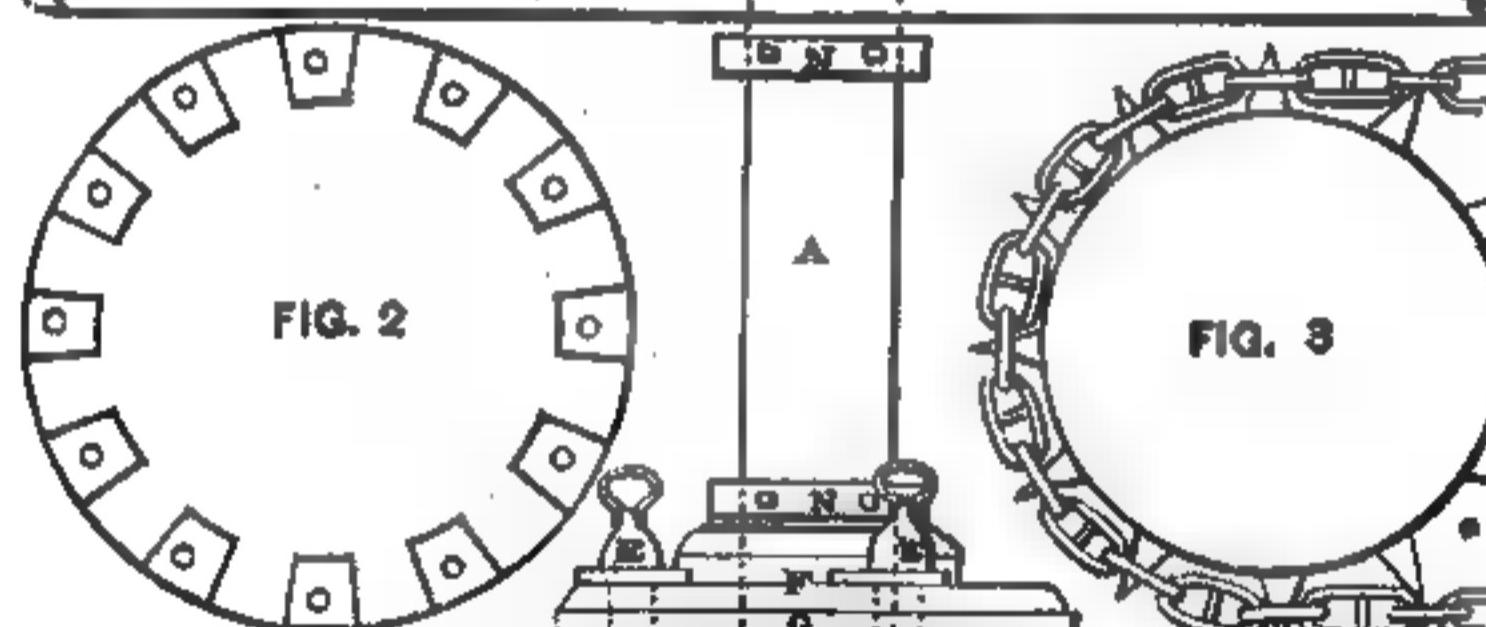
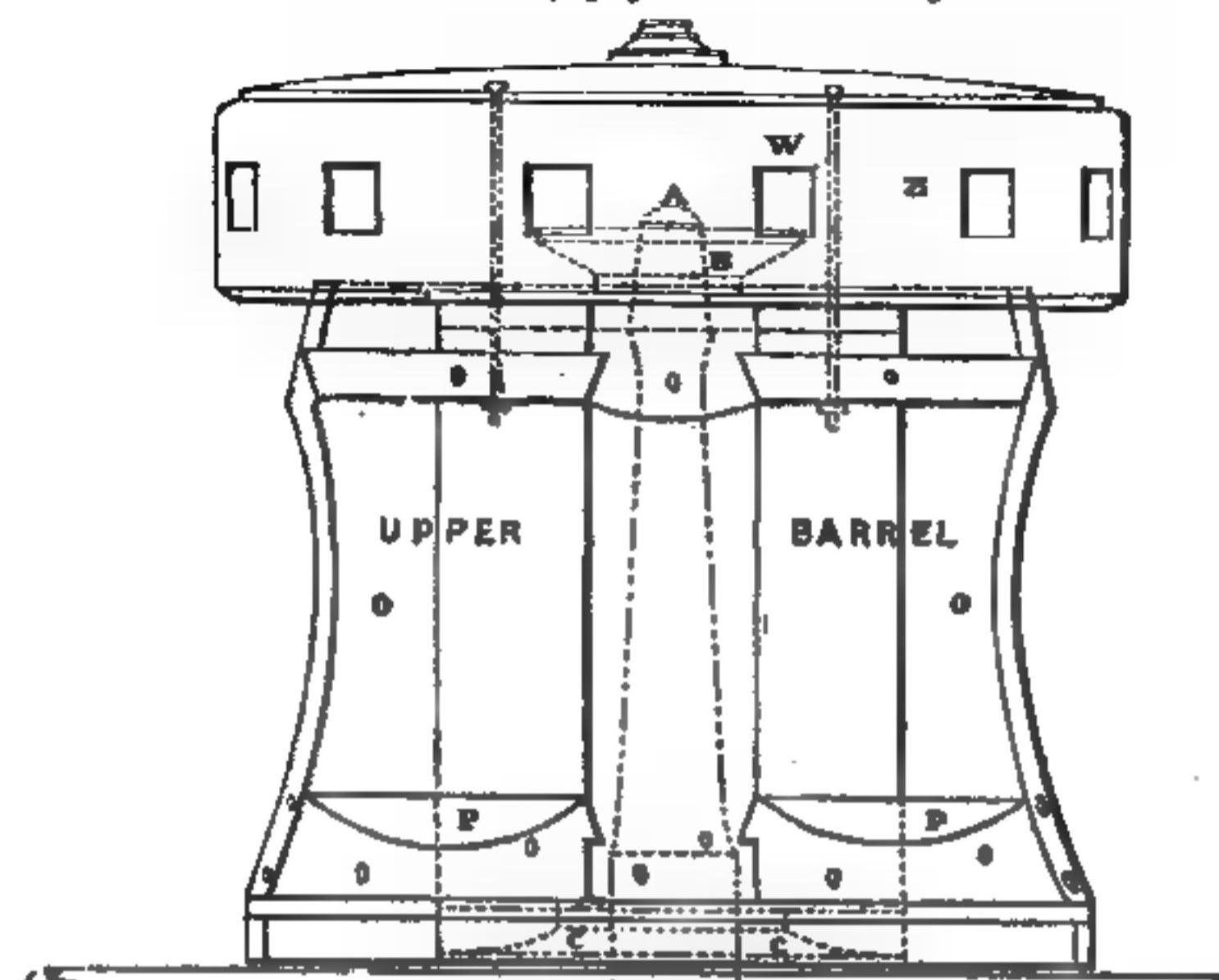
DESCRIPTION OF PLATE 10, OF ■■■■■ CAPSTAN.

Scale, $\frac{1}{2}$ of an inch to a foot.

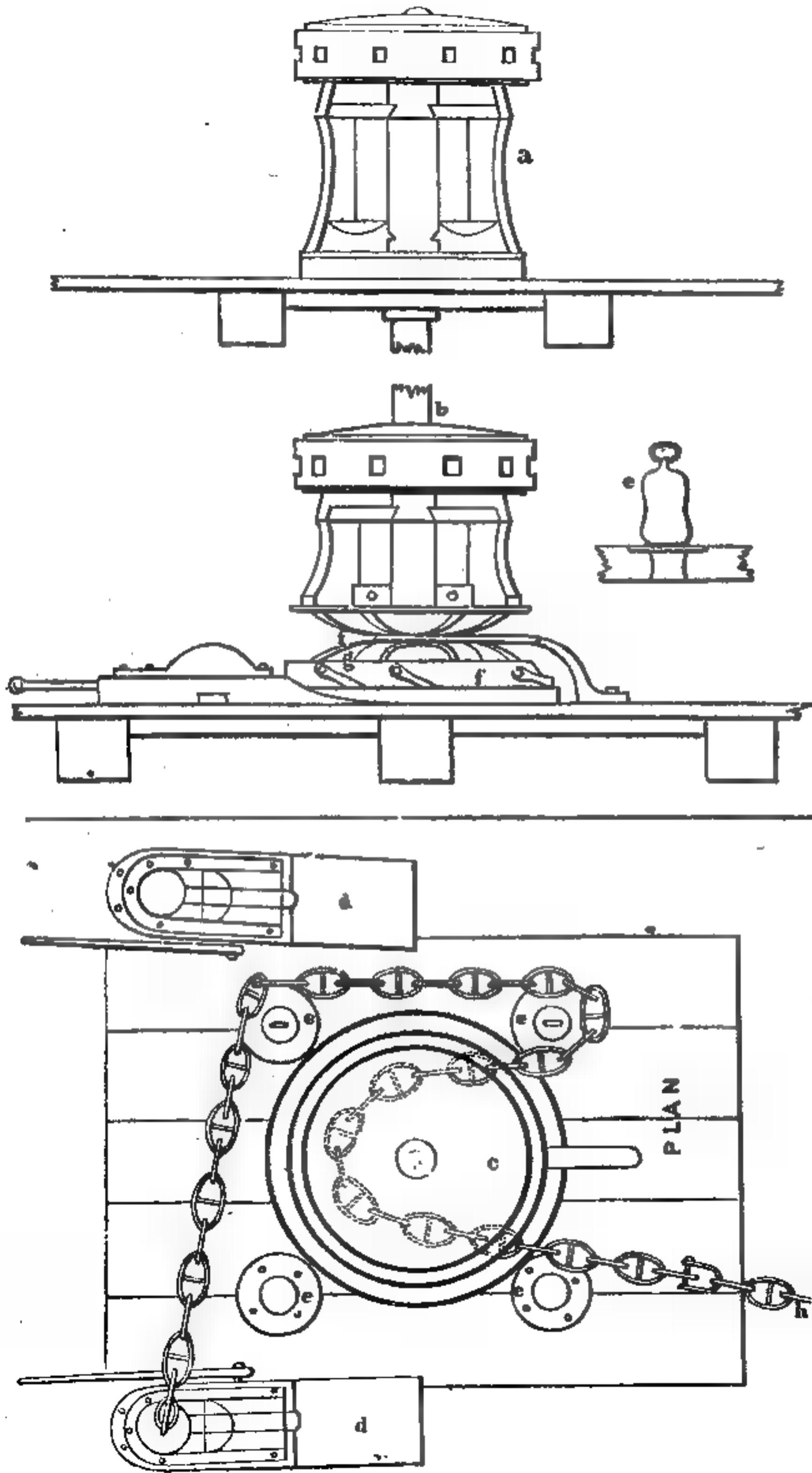
The mechanical power employed in ships of ■■■■■ and in the large vessels used for commercial purposes, to heave in the cable, and thereby raise the anchor, is a modification of the wheel and axle, or of one of the six standard machines of mechanical science; it is technically denominated a capstan—one portion of which, called the barrel, round which the rope ■■■■■ wound, answering to the axle of the mechanical machine; the other part, the head with the bars, being analogous to the wheel of it. To set this machine in motion, ■■■■■ moving power (the crew ■■■■■ ship's company) ■■■■■ applied to the bars of the capstan or wheel, and the rope being by this means wrapped round the barrel of the capstan or the axle of the machine, ■■■■■ the weight or cable is raised. The cable itself is not generally attached to the barrel of the capstan, but it is connected with it by the intervention of a rope or chain called a messenger which does pass round the capstan, and is made to unite itself firmly to the cable by what in nautical terms ■■■■■ styled nippers, ■■■■■ being expressive of the close connection they ■■■■■ between the cable and the messenger. The messenger before mentioned is ■■■■■ rope or chain formed into ■■■■■ long loop, and in length, when of rope, so as to allow of three or four ■■■■■ of it round the barrel of the capstan and then for each part ■■■■■ reach to the hawse holes, the two ends being there united to form ■■■■■ endless rope. When ■■■■■ chain messenger is used *, the links of the chain messenger ■■■■■ worked over studs placed on the capstan, as shown by fig. 3, which decreases the length of it by the three ■■■■■ four turns round the barrel or axle of the capstan which are required when ■■■■■ hempen messenger is used ■■■■■ withstand the strain brought on it, and prevent the messenger from slipping round the barrel of the capstan.

The fitments of the capstan should ■■■■■ be slighted, the efficiency of it being essential to the safety of the ship, and its power and facility

Plate 10, Fig. 1.
Scale, $\frac{1}{2}$ of ■ inch to ■ foot.



Brown's Patent Fittings ■ Capstan, without Messenger.



for ■■■ should be increased as much as the simplicity required in all mechanical agents for ship use will allow. But the ■■■ of mechanical contrivances for increase of power in the capstan, which involve iron in their construction, should, for nautical purposes, be adopted with caution, as the corrosion which rapidly takes place in that metal, tends to render them inefficient, while the jerk or surge which will necessarily arise from the power used, that of men rallying ■■■ jerking at the bars of the capstan, cannot fail to break the iron. The complement of men on board a man-of-war, is always sufficient, under ordinary circumstances, to purchase or raise the anchor by a capstan of the most simple construction, and thence increase of power, or what may be termed the means of dispensing with a number of men, is not a consideration; for it should ever be remembered that no increase of power can take place, without a corresponding decrease of velocity in the weight raised; or, that if 40 ■■■ were required to raise the anchor by the capstan when under the old form—that of the simple wheel and axle, and that by mechanical contrivances being attached to the capstan, 20 men were enabled to do the ■■■ work, then the 20 ■■■ would have to move the improved capstan round twice as fast as the 40 men moved the old capstan round, or otherwise they would be twice as long about it.

References to Plate 10, of the Capstan, p. 136.

Fig. 1.—Elevation of a double capstan ■■■ of such as are usually fitted to frigates and line-of-battle ships of the navy. It shows in perspective the whole machine; in frigates the upper barrel ■■■ on the quarter deck, the lower barrel being on the upper deck, ■■■ which the hawse holes also ■■■ placed. In the line-of-battle ships the lower barrel is on the lower deck and the upper barrel on the upper deck or middle deck, according as the ship is ■■■ with two or three tiers of guns, all fore and aft of her.

A & A, Iron spindle extending from upper point A to the lower point marked A'. This spindle should be well forged, and should be of the best materials, the whole strength of the capstan depending thereon; it is also placed in a turning lathe, by which the cylindrical form requisite to make it work accurately is ensured.

B, Hoop and plate ■■■ the tenon of the upper barrel, by means of which the barrel ■■■ united to the spindle A at the upper part.

C, A similar plate and hoop for security of the lower end of the upper barrel of the capstan.

D, Hoop in the partners of the upper deck working in a metal bush or socket, thus forming a support for the spindle A to work in through the partners ■■■ deck.

x, Drop pauls or pins to connect the upper and lower capstans; and here an explanation is required, which is this: that the spindle A passes through the lower capstan without being united to it, or, in other words, the lower capstan has free play or movement round it.

y, Upper connecting plate, which is strongly secured to the spindle A.

z, Lower connecting plate, which is let firmly into the trundle head H; in and a corresponding holes are made to receive the drop pauls (x). To attach the lower capstan to the upper one, to the spindle A, the drop pauls, x, are let down through the corresponding holes for their reception in the connecting plates z and a, by which the trundle head of the lower capstan, and thence the barrel of it, is made with the upper capstan. This power of connecting and disconnecting the two barrels capstans gives the facility of using the capstans and the time for separate purposes—the of heaving the cable in, and the other to raise the lower yards to the top-masts.

t, Paul head; receiving the pauls or stops to prevent the recoil of the capstan.

s, A paul or shore of iron swivelling on a bolt, which is shown up in the position in which it is placed when not required for use.

r, The same paul or similar one, down and in use—the lower end being dropped into the paul rim v against a stop formed in it.

v, Paul rim or racket, let down into the lower partners and bolted firmly to them; indeed the security of this rim the safety of the the bars mainly depends, and care should be taken in fitting it. The plan section of the paul rim is described by fig. 2.

u, Metal step or socket for the lower end of the spindle to work in.

w, Collars or stops on the spindle A; the upper one is necessary to keep the capstan from rising, which it would prevent by its coming in contact with the underside of the partners at D; the lower collar prevents the lower capstan, when used separately from the upper, from rising by its forming a stop to the upper connecting plate y, should the lower capstan be forced while in use.

x, The whelps or ribs of the capstan; they are formed in a to give the surge which is required to prevent the turns of the messenger or the barrel of the capstan from rising too far up them.

p, Chocks placed between the whelps to steady them.

q, Holes to receive the bars which work the capstan; to these bars when shipped in place, holes are bored down through the head of the capstan and through the bars, and pins are placed in them, and in addition the outer ends of the bars have a rope wound round them to join them all together, and the latter is termed swifting the bars.

Fig. 4.—Section of a capstan bar, ■■■ on scale. The number and length required to each rate or class of ship of ■■■■■ subjoined :—

Rate of Ship by the number of Guns.	No. of Bars.	Length of Bar.
From 10 to 14 guns	8	8 6
From 16 to 18	10	9 0
Corvette of 800 tons measurement	10	9 6
Ship of ■■■ guns	10	10 0
■■■ 36 to ■■■ guns	12	11 6
■■■ 74 guns	14	12 6
" 80 "	14	13 0
" 100 to 110 guns	14	13 6
" 120 guns	14	14 0

Plan and Section of a Capstan fitted by Brown, of London, for the ■■■ of the Chain Cable without the intervention of a Messenger, vide Sections, p. 137.

- a, The upper capstan fitted ■■■ formerly described.
- b, Elevation of the lower capstan with fittings ■■■ the lower part of it formed of iron, the ribs, *g* and *g*, in it acting like teeth or sprockets ■■■ clasp the cable, similarly to the sprocket-wheel with studs, ■■■ shown, Plate 10, fig. 3, of the common capstan, when a messenger is used.
- c, Elevation of a friction roller, round which the cable is wound ■■■ shown on the plan, four being used ■■■ marked, *e*.
- d, Of the plan shows the compressor for stoppering the cable.
- e, The cable leading the hawse hole. The method of bringing the cable to the capstan may be traced on the plan; the links shown in dotted lines being those in contact with the ribs (*g g*) of the elevation.

The merits of this plan consist in not requiring the intervention of a messenger, whereby the hands required for passing the nippers, which unite the cable and messenger when a messenger is used, ■■■ saved; but this method makes it necessary that the cable locker, ■■■ compartment for the reception of the chain cable, should be immediately below the position of the capstan; an arrangement that is not always convenient in a ■■■ of-war.

The windlass used in small vessels is a capstan, with the barrel worked horizontally, the power being applied by levers, which ■■■ shipped or worked in holes similar ■■■ those in the capstan head.

PART XXIV.

Rudder, its Action.—Efficient Angle ■ the Fore and Aft Line of the Vessel.—

Round-headed Rudders, when and where first introduced.—Advantages arising from the Use of them.—Round-headed Rudder, from its conversion, subject to weakness.—References to Plate 9.—Wood-lock of the Rudder described.—Rudder Pendants, and their Use.—Temporary Rudders ■ Her Majesty's Navy.

DESCRIPTION OF PLATE 9,

And reference to the several portions of ■ Rudder when fitted with a round Head, or that the part in which the Tiller is fixed is circular; the Hangings of the Rudder being those introduced into Her Majesty's Service under ■ Patent taken out by Capt. Lehon, of the Royal Navy.

The rudder, it should first be premised, governs the movements of the ship—the tiller by which the rudder is moved on its hinges or pintles being forced in ordinary cases the opposite way to which the head of the ship is required to be moved; this action of the tiller places the rudder itself across the line of water passing along the bottom of the ship, and the water, impinging on the rudder, forces the ■■■ of the vessel, and consequently her bow, to pivot round ■ centre of motion. Theory has demonstrated that the rudder, for efficiency in turning the ship round, should never be forced over by the tiller beyond the angle of 42° from ■ fore and aft line, and experience ■ practice has confirmed this theoretical result; and it will be found that, in Her Majesty's service, arrangements ■■■ made (that will presently be pointed out) to prevent the rudder being forced ■■■ beyond that limit. Round-headed rudders, which with their fittings ■■■ now to be described, ■■■ first introduced into the ships forming the mercantile navy of the East India Company. The advantage arising from this form of rudder and mode of hanging it is this, that the hole through the counter or stern of the ship which is called the helm port, is wholly closed up by the head of the rudder passing through it, with almost a close joint, ■ the line of the centre of the pintles or hinges is made to pass through the centre of the rudder head, whereby the round head of the rudder becomes a large pintle or hinge working in the counter or helm port. On the old system of square rudder heads, the line of the centre of pintles ■■■ the half diameter of the pintle before the fore side of the rudder head, and the rudder, necessarily working on the centre of the pintles, required that the hole through the counter of the ship for the reception of the head of the rudder should be made large enough ■■■ allow of the rudder working over with a radius equivalent to the diameter of the rudder head; the large helm port which was thence formed ■■■ found to be

The plan, or the of the round-headed rudder, is not however without objections—as the upper pintle hinge (without great precaution is used in the conversion of the main pieces of the rudder), when let or into its place, cuts far into the main piece which also forms the round head, as seriously to injure the strength of it; and with the long head above this pintle, which in the first instance unsupported, the rudder head wrung off, in instances below the upper pintle. This difficulty has been met in practice by the upper part of the rudder head itself being made to work in a collar formed on the deck nearest to where the tiller works, the head of the rudder thus becoming the upper pintle, and the one on which the greatest strain is brought when the rudder is in action; the former pintle, which under such provision is then the second, being acted on like the others below, on only an hinge on which the rudder turns.

Scales used in the Figures. Figs. 1, 2, 4, 5, 1½ inch to a foot;

Fig. 3, ¼ of an inch to a foot.

References to Plate 9, of the Rudder.

a, Fig. 3.—Long rudder head made round, or what is termed circular.

a b, The whole length of the main piece, shown extending the entire length of the rudder; it is usual in large ships let the main piece run down below the second pintle, the lower part being made good by a lengthening piece. The main piece is usually of oak.

c, A piece of elm worked on shown, to give the form of the rudder on the fore side, and prevent the main piece (a b) from being injured by the letting on the pintles (d).

e and f, Usually pieces of fir to make up the form of the rudder.

g, The braces or gudgeons, fixed to the stern post and bottom of the ship receive the pintles. The pintles and braces are bolted and screwed through the of them, respectively to the rudder and post.

At the lower part of the rudder, on what is termed the heel of it, a sole piece is worked, being a piece of plank usually 6 inches thick at the ends of the pieces, c b, e, and f; should the ship take the ground lightly, this sole piece, by acting to the rudder like the false keel to the vessel, would easily break off, and perhaps free the ship from danger.

The sections of the rudder and post, marked i and k in the plate (fig. 1), show the angle bearding taken off from the post and the rudder, to allow the rudder to work over each way through an angle of 42° before the fore side of it will come against the aft side of the main post; this is the preventative alluded to in a former paragraph. The other sections (fig. 4) are those of the pintles (d) and braces (g) upon a larger scale, showing at l and m the of the pintle and brace of a set. The intention of the crowns is to the pivots on pintles working truly on each other.

a, h, Figs. 5 and 6.—Are enlarged sections of the pin that is fixed in the pintle (*d, fig. 3*), and great care should be taken in letting ~~in~~ the braces to the bottom of the ship, and the pintles to the rudder, that they may work with each other ~~in~~ one joint: as an efficient and easy way to accomplish this end, it is suggested that a long rod of wood be employed of the ~~same~~ diameter as the pintle ~~is~~ *h*, and that this rod be secured up and down the stern post with its centre in the position that will be finally occupied by the centre of the pintles—then each brace being threaded on this rod, and let ~~in~~ to the bottom from it, will give the positions of the braces correctly, while a line got ~~in~~ the rudder for the centre of pintles, will be equally as effective in fixing the pintles.

There is also fitted ~~in~~ the rudder what is called a woodlock, which is a piece of wood placed in a score, cut out of the rudder under the brace which receives the pintle that is immediately below the water line of the ship when loaded; this woodlock is made to have its upper end bearing against the under side of the brace, and the lower end against the ~~bottom~~ in the rudder; by which means, the rudder is prevented from rising or being unhung by slight concussion. The woodlock is usually nailed in its place. There is also usually a bolt in the rudder placed just above water in the back of it, for the reception of what is termed rudder chains; which are metal links for a short distance shackled to the bolt alluded to, the other parts being made up of rope pendants, which are fastened round the stern and led ~~in~~ the quarters, where they are firmly secured to bolts driven to receive them; the use of the rudder pendants is, to prevent the loss of the rudder, should it be unshipped ~~in~~ by any casualty.

The practice is to fit temporary Rudders ~~in~~ Her Majesty's ships, but a description of them would be foreign to this work.

PART XXV.

Remarks ~~on~~ the Application of Steam ~~in~~ the Propulsion of Ships; first, when used ~~as~~ a Prime Mover; secondly, when applied as an Auxiliary to the Sails.—Description of Plate 11, ~~in~~ references to the Elevation, Plan, and Section of a Paddle-box of a Steam-boat.—Modes of putting the Boat into the Water, and taking it out.—References to Plate 12, or a descriptive Sketch of the Aperture for the Screw Propeller.—Mode of raising the Propeller adverted to.—Danger that would arise from a Vessel propelled by the Screw touching the Ground.

WITHIN the period of the last twenty years, a great revolution has taken place both in the armed and commercial navies of this country, and perhaps the ~~most~~ especially ~~in~~ in the first—the British Navy. The application of steam to the propulsion of ships through the water, has converted the track-

■■ regions of the ■■■■■ it were into evanescent railroads, whereby the fickle ■■■■■ uncertain winds are disarmed of their powers of delay, by man having a power placed in his hands, by which he can with ■■■■■ dispel the listlessness of the calm, ■■■■■ render nearly nugatory the adverse storm—when either tend ■■■■■ check the progress of the vessel. It would be far from the immediate province of ■■■■■ rudimentary work ■■■■■ ship building, and more particularly so in ■■■■■ treating ■■■■■ the practice of that art, to attempt to point out the rise and progress of steam ■■■■■ applied ■■■■■ the navigation of the sea; suffice it then to say, that although Dr. Lardner ■■■■■ the early stage of its application pronounced that it ■■■■■ impossible for vessels to pass the broad barrier of the Atlantic Ocean by the power of steam, the learned doctor lived long enough, to take advantage of the triumph of man's ingenuity and indomitable perseverance by personally witnessing the passage to America made by ■■■■■ vessels, ■■■■■ nearly certain ■■■■■ to the time of arrival in port ■■■■■ that of the mail coach at the inn ■■■■■ shore, and to hear that the world had been circumscribed by the ■■■■■ description of locomotive machines. The building of the hull of the steam vessel for ■■■■■ is accomplished by the same process as that which has been described for the sailing ships of the navy, and the fore and after parts of the one assimilate to that of the other, and the same requirements are necessary in the internal arrangements of both classes of ships for the accommodation of the officers and crew, the stowage of the stores and provisions, and the reception of the equipments of ■■■■■ vessel designed for warlike purposes; but the centre portion of the vessel to be propelled by steam differs essentially from that of the sailing one, and may fairly be said to be an addition introduced between what would otherwise, when united, form a sailing ship; the engine-room, comprising the compartment that is required for boilers, engines, and coal bunkers, being ■■■■■ space that ought ■■■■■ to be a blank in the internal capacity that may be considered due ■■■■■ the stowage of the ship's stores and equipments; or, in other words, that the body of the ■■■■■ ship before and abaft the engine-room, should constitute . the perfect man-of-war in all respects of stowage, ■■■■■ the engine-room should be looked upon merely ■■■■■ a receptacle for the internal power of locomotion.

Steam vessels have had two ■■■■■ applied to them for moving them through the water. The ■■■■■ of longest date, termed paddle-wheels, is in principle of action similar to that of the railroad carriages of the land—the paddle floats of the one acting on the resisting medium of the water, aptly bearing comparison with the resisting medium caused by the friction of the carriage wheels on the rails of the other.

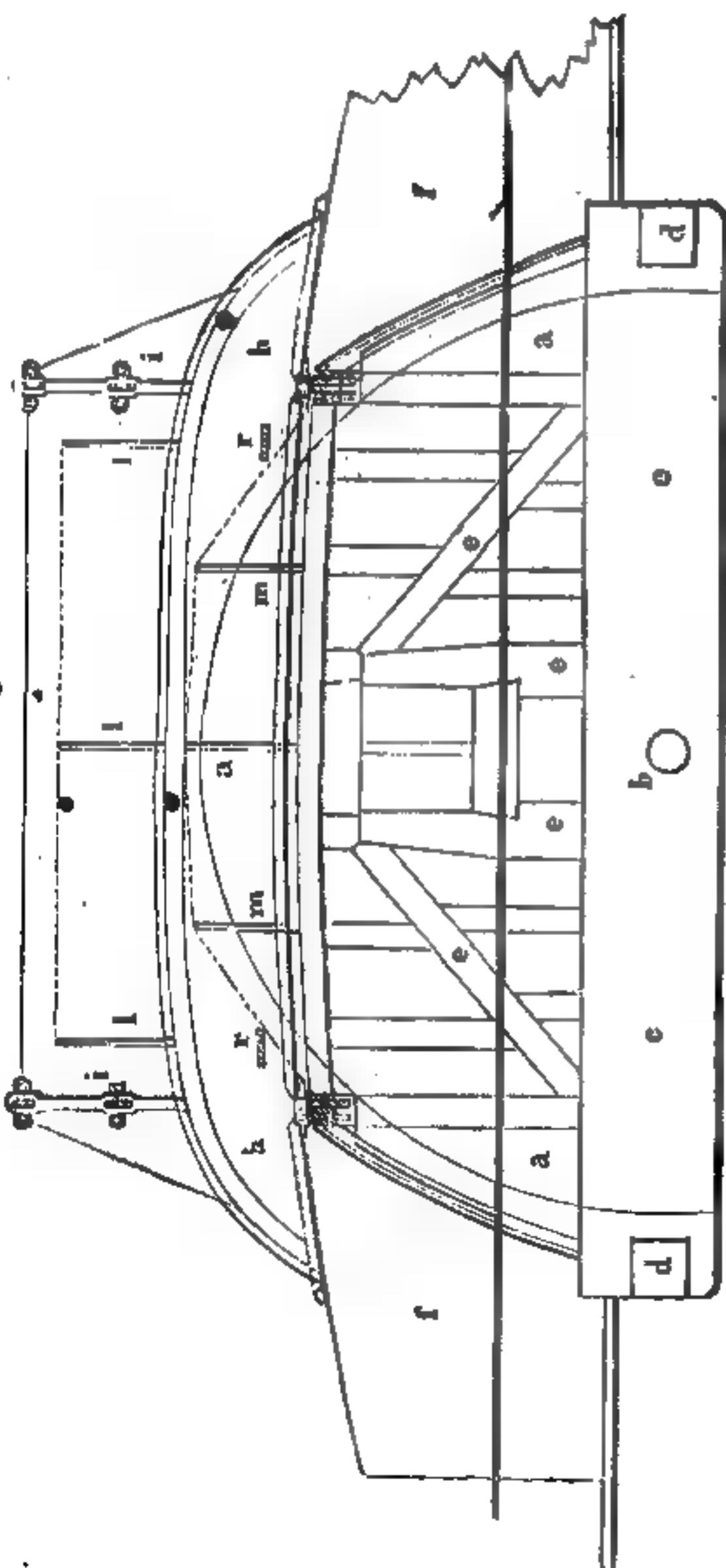
The other method of producing motion in a steam vessel is the ■■■■■ pro-peller introduced by Mr. Smith, and it may with justice be styled a modification of the ancient and effective practice of sculling ■■■■■ boat with ■■■■■ oar;

The relative capabilities of these systems is certainly not within the limits of the descriptions that should be given in this work : the outline of the propelling actions (with steam as the prime mover) in the two is all, then, that will here be attempted.

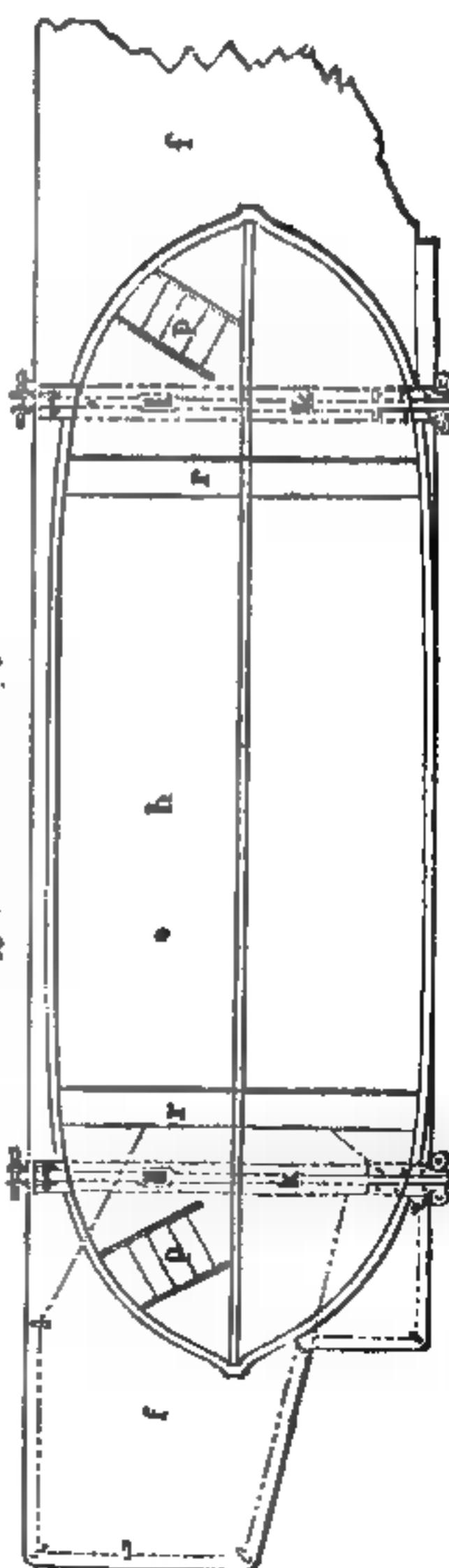
Plate 11.

Elevation, Plan, and Section of a Paddle-Box of a Steam Boat, showing the arrangements made by Davits for throwing into the water, & raising from it, the Paddle-Box Boats.

ELEVATION.



PLAN.



Scale, $\frac{1}{8}$ of an inch to a foot.

Description of Plate 11, illustrative of the Propelling Action of Steam when applied under the form of Paddle-Wheels to Vessels; showing also the arrangements which are made that the upper part of the Paddle-Boxes, or Covers to the Paddle-Wheels, may be formed by Boats termed Paddle-Box Boats, and including Sections depicting one of the methods by which these Boats, when required, are placed in the water or raised from it.

The form and action of the paddle-wheel of a steam boat are so well known to most men of our sea-girt isle, that little is required to be written to point out the principle on which they act. Under this impression it only remains to give to those who have never traversed the water by the aid of steam, the idea of associating the action of the water or tide mill of the inland stream with that of the paddle-wheel of the steam boat. In the first, the water by flowing against the wheel gives motion to it, which again by machinery communicates the same to the stones that grind the corn ; while in the second —— (the ship), the power of steam within board communicates rotatory motion to the paddle-wheels partly immersed in the water, causing a resistance to arise from the water against the floats of the wheel that produces motion in the vessel.

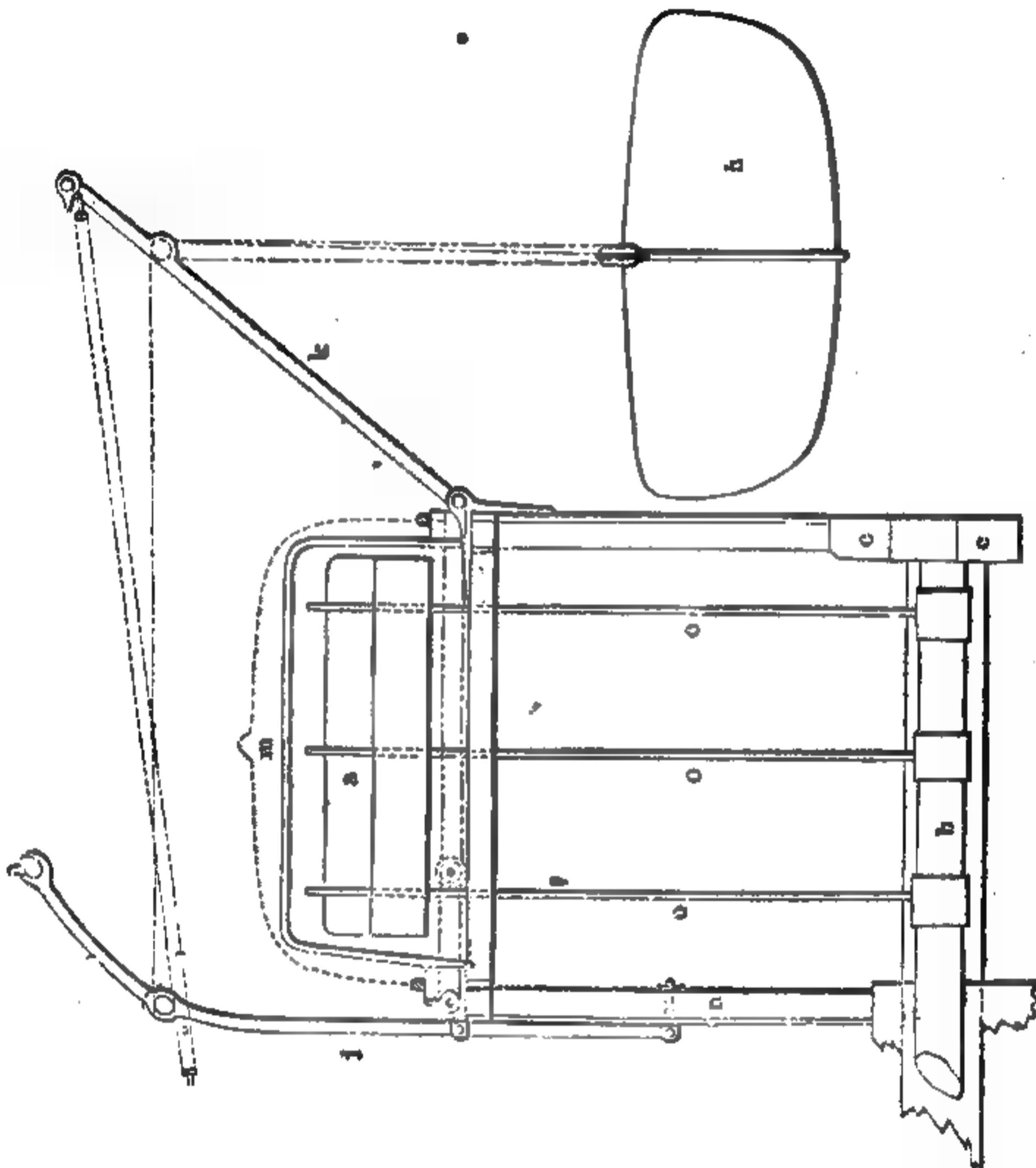
References to the Plan, Section, and Elevation of the Paddle-Box of a Steam Vessel.

a, In the elevation, denotes the extreme edge or extension of the paddle floats or boards, one of which boards are pointed out in the section by the corresponding initial letter *a*, where the surface of them is given. These floats vary in thickness, length, and breadth, according to the peculiar views of the maker of the engines. Observe that the surface they should present to the water depends on the relation that the power of the engines bears to the weight and form of the ship. Too large an amount of resistance, produced by an excess of surface in the paddle floats, would produce over work for the engine ; while too little surface could not fail to allow of the wheel revolving without forcing the vessel ahead ; in other words, there is a certain immersion of the float of the wheel, surface of float, and revolutions of paddle-wheel per minute, which will give the maximum velocity to the ship.

b, In the elevation, is descriptive of the size of the end of the paddle shaft, which is shown on the section extending from the side of the ship to the spring beam (*c*). In these later days of steam power the spring beams (*c*) have been dispensed with, the shaft (*b*) revolving on a chock secured to the side of the ship, instead of the outer end being borne on the plummer block attached to the spring beam (*c*). The lines marked *o* in the section are

SECTION.

Scale, $\frac{1}{8}$ of ■ inch to a foot.



c, Of elevation, the spring beam placed fore and aft or lengthways of the vessel — the ends of the paddle beams (d); the spring beam supports the plummer block or gudgeon, which receives the outer end of the shaft (b), and forms also a base for the reception of the frame work (e) of elevation, which is part of the bed necessary for the paddle-box boat.

d, Of elevation, the ends of the paddle beams through the spring beams (c).

e, Of elevation. Truss framing, to form the paddle-boxes, the lower portion of which is birthed, or covered in with boards, the upper part being formed into gratings — lattice-work for the escape of the air.

- f, Of elevation, technically termed paddle walks, being an extension of the paddle-boxes, to receive the ends of the paddle-box boats, and the under parts forward and aft, marked f, to be available for washing houses, galley, colour ■ flag lockers, &c.
- h, In all three of the figs., is descriptive of the paddle-box boat. In the elevation it describes the boat ■ being placed with the bottom of her upwards, forming the top of the paddle-box. In the plan the breadth of the boat is seen, and the space (h) in which the paddles work ; while in the section h shows the boat slung by the davits k and i, ■ being ready either for being lowered into the water or hoisted on board ; the ropes or falls are denoted by ticked black lines.
- i, In the elevation and section, inner davit of paddle-box of iron.
- k, In plan and section the outer davit of paddle-box. In the plan, the boat is shown laying on it, being in place ; and in the section, the boat has been turned ■ and out by the outer davit (k) having been raised by ■ of the crooked arm of the inner davit (i).
- l, Of the elevation, stantions for man ropes temporarily fixed to the keel of the paddle-box boat ; the man ropes forming ■ safety to the crew while passing over the boats.
- m, Both in elevation and plan, illustrative of guard irons to prevent the boat's bottom from being forced by accident into the wheels.
- p, In the plan, ladders to afford facility to the crew in ascending the paddle-box boat.
- r, Of plan and elevation, points out the positions of the fore and after thwarts of the paddle-box boats, or the fixed seats for the rowers of them.
- Another plan for a pair of single straight davits has of late years been adopted in Her Majesty's service for this evolution ; it is said to be more simple in its operation, which is doubtful, but the method is certainly much less expensive to fit.

REFERENCES TO PLATE 12.

The aperture for the propeller is cut in the ■ of the vessel, or in what is termed the after deadwood of the ship. To effect this two stern posts have been introduced, the fore one called the body post, or what might be with more propriety termed the abutment of the after deadwood, and the after one called the rudder post. In fact, ■ hole or aperture (l) is required for the screw ■ propeller to work in, and the body post, as it is named, makes the fore side of such aperture. The shaft (c) runs through the body post in ■ water-tight stuffing box, and the propeller is turned

rapidly round in the aperture (*b*) by means of a long shaft connected with the steam-engine amidships.

a, Shows the rudder post or the foundation to which the rudder is hung.

The other part of the plate shows a frame-work and section of ■ apparatus that is fixed for raising the propeller out of water, when the vessel is required to make use of her sails, independently of the auxiliary power of steam; there is a trunk formed above the aperture (*b*) up to the weather deck, that the propeller may, when it is requisite, be lifted out of the water and put on it. The apparatus usually fitted will only raise the propeller out of the water, leaving the other part, that of placing it on the deck, to be done by the sailor with tackles. It is much to be doubted whether the use of the tackles throughout would not be the most economical mode of effecting the operation.

The screw propeller and its fittings have yet to be tested, under the trial of a lee shore and the touch of the heel of the post on a rock—a reference to the plate will point out the defenceless state of the after part of the vessel under such a misfortune; but such things as striking abaft have occurred to sailing vessels that have escaped with trifling injuries; should the same evil overtake the vessel propelled by screw, it is to be feared that the loss of a rudder and the plank of the bottom wrenched out by the shaft of the engine, would render the same accident fatal to the ship and crew.

PART XXVI.

References to Sketch 13, descriptive of some of the Ordnance employed for Naval Purposes, and of the Fittings for their Use.—Weight of Powder in Shells.—Number of Shells for close Action.—Table of Powder supplied for each rate of Ship in Her Majesty's Navy.

THE largest guns that were used ■ board Her Majesty's ships during the last war, if those in Her Majesty's ship Glatton, which carried 68 lb. shots, be excepted, did not exceed in length 9 feet 6 inches, and 56 cwt. in weight, carrying a shot of 6½ inches in diameter, weighing 32 lbs. Guns of that calibre formed the lower tier of armament of line-of-battle ships, or of those ships which had two ■ three ranges of artillery. In the present day the guns employed in the ■ service have been increased in weight up to 100 cwt., and in length to 10 feet 6 inches, carrying a shot of 10 inches in diameter, and of 84 lbs. in weight. These have hitherto been employed principally for pivot guns in steam

vessels, but the probable effect that such guns when used in steam vessels would have — line-of-battle ships in a calm, has led to the contemplated introduction of these large guns on the poops of sailing ships now building; doubts, however, have been entertained whether the crews of the steam vessel or line-of-battle ship, could efficiently handle such heavy missiles — the shots of such guns, in even moderate weather: and both shot and guns would certainly be equally uncontrollable in really bad or tempestuous weather.

*Port of the Lower Deck, fitted to receive the common 32-pounder long Gun
on common Carriages.*

Weight of gun	56 cwt.
Length of gun	9 ft. 6 in.
Weight of carriage	9 cwt.
Ports { Wide, or fore and aft.....	3 ft. 6 in.
Deep	2 ft. 11 in.
Centre of metal to be from 3 ft. to 3 ft. 1 in. above the deck.	
Height of lower port sill from deck, 1 ft. 4 in.	

Fig. 1 is descriptive of the front elevation of the port, with the relative positions of the several eye bolts and ring bolts required for the manœuvring and fighting of the guns. An eye bolt is a bolt stave of round iron cut off to the length required to go through the side of the ship shown by fig. 1, and to have an eye formed in it of $2\frac{1}{2}$ times the diameter of the iron used to make the bolt. Thus, an eye bolt of 1 inch diameter would have an eye in the clear of $2\frac{1}{2}$ inches. A ring bolt is the forming a ring in the eye of the bolt above described, the diameter of such being in the clear 5 times the size — diameter of the iron of the bolt, or, assuming — inch bolt, it would be 5 inches. The eye bolts, when used in gunnery, — to receive the hooks of the tackles by which the guns — trained — pointed, — run out, and the ring bolts receive the breechings of the guns, which — strong ropes led round the breech of the gun to overcome the recoil of it when it is fired.

a a, Fig. 1.—Eye bolts in the shelf of the upper deck, called muzzle lashing bolts. The muzzle of the gun, or *k* of fig. 2, in bad weather, is placed against the shelf between them, and strong lashing passed round it, and through the eye bolts (a a). — 1 inch in diameter.

b, Eye bolts for the train tackles — pulleys, by means of which the gun is made to point with its muzzle (*k*) forward, aft, or amidships. These tackles are also used to run the gun out after it has been loaded. Bolts 1 inch in diameter.

Sketch 13.

Fig. 1.—Lower Deck Port.

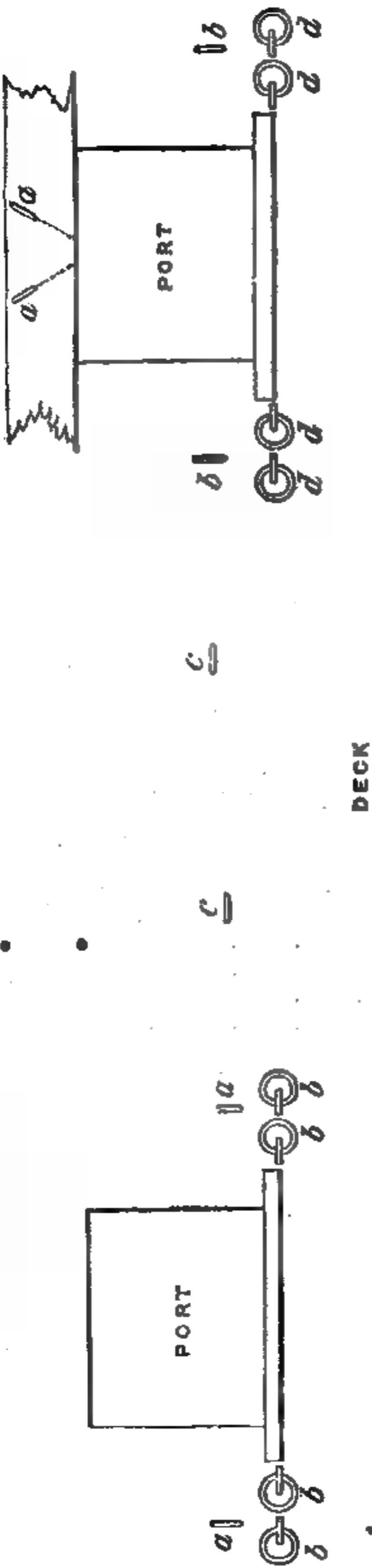


Fig. 3.—Quarter Deck and Forecastle Carronade Port.

c, Eye bolts placed between the ports for extreme training of the muzzle of the gun — far forward — aft as the side will admit.

d d, Breeching and preventer breeching bolts; the first from the side of the port receives the breeching — rope security (g, fig. 2), used to restrain the recoil of the gun; the other is called a preventer bolt, being intended as a resource in the event of the breeching bolt being disabled. Iron for bolts from $1\frac{1}{2}$ inch to $1\frac{3}{4}$ inch in diameter.

Fig. 2.—Section of the side of the ship, showing the thickness of timber and plank, also deck and beam. The gun and carriage are also shown sectionally.

e, Chamber of the gun, or receptacle for the powder.

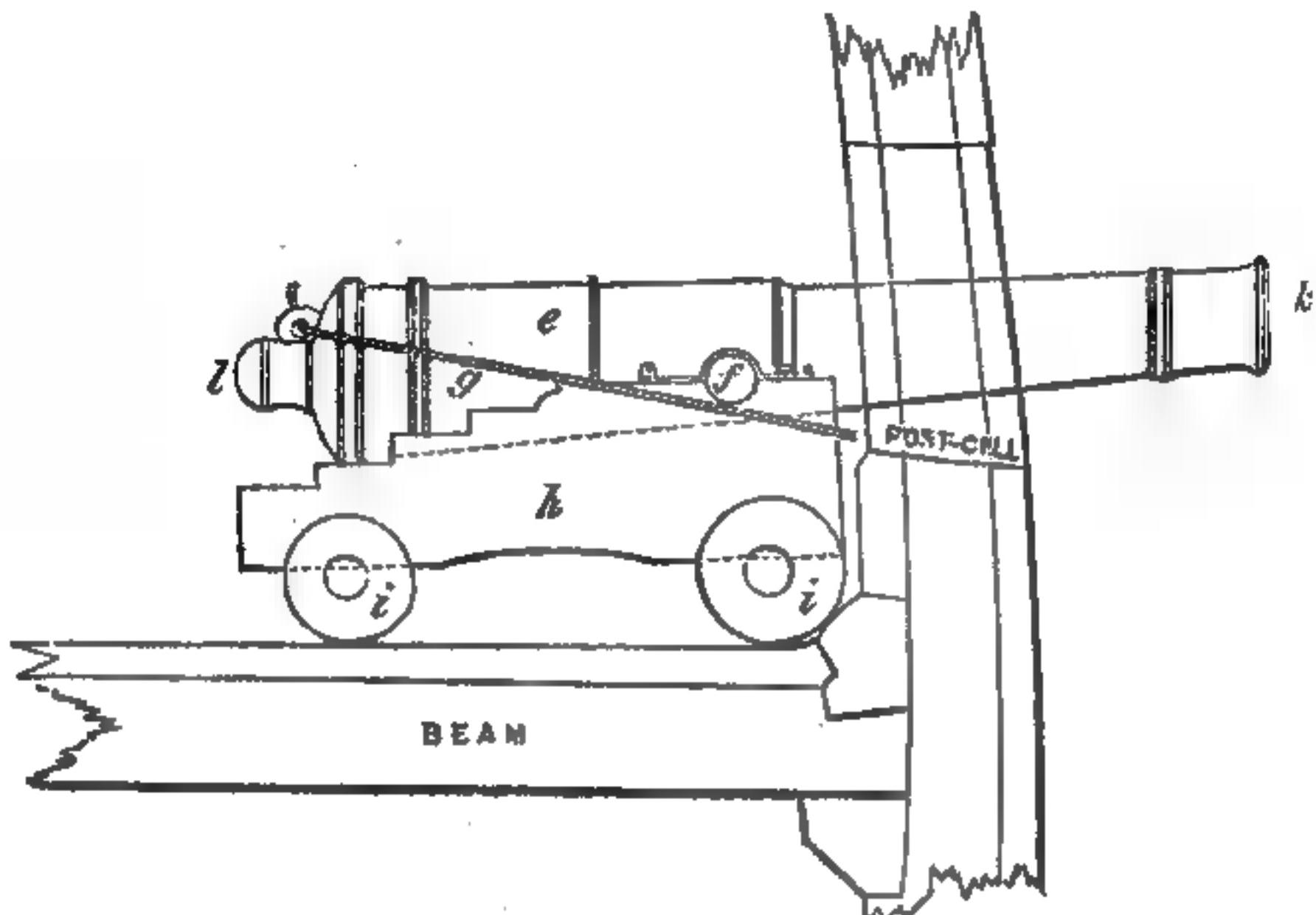
f, Trunnion or axle of gun. The upper side of f, or trunnion, is usually in the line of the centre of metal or centre line of the gun.

g, Breeching, made of the best white rope, secured to the ship's side through the bolts (d, d) of fig. 1, and passing through the breeching ring (g) of fig. 2.

h, Carriage of wood, weighing 9 cwt.

i, Wooden wheels to facilitate the movements of the guns; they are called trucks, and distinguished by being called fore and hinder trucks.

k, Muzzle of the gun, or the portion of the gun at which the aperture is made, which receives the powder and shot. These guns, of 32-pounders calibre, have now a portion of the 80 rounds of shot formerly supplied for each gun made up of filled shells of the — diameter — the shot, viz., $6\frac{1}{2}$ inches.

*Sketch 13.**Fig. 2.—Section of the Port and Gun.**Shells filled with Powder.*

Viz., For two 32-pounder guns (fig. 2), of 56 cwt. in each frigate, 40 in number: not any shells allowed for 25 cwt. 32-pounder caronades.

Quantity of Powder required for filling Naval Shells.

	lbs. oz.
Shells, 10 inches in diameter	5 11
" 8 " " " "	2 4
" 56 pounders	1 12
" 82 " " " "	1 0

*Shells additional for close action.**Rate of Ship.*

1st	300	6-inch shells for 32-pounder guns.
2nd	200	
3rd	200	
4th	120	
5th	100	
6th	70	

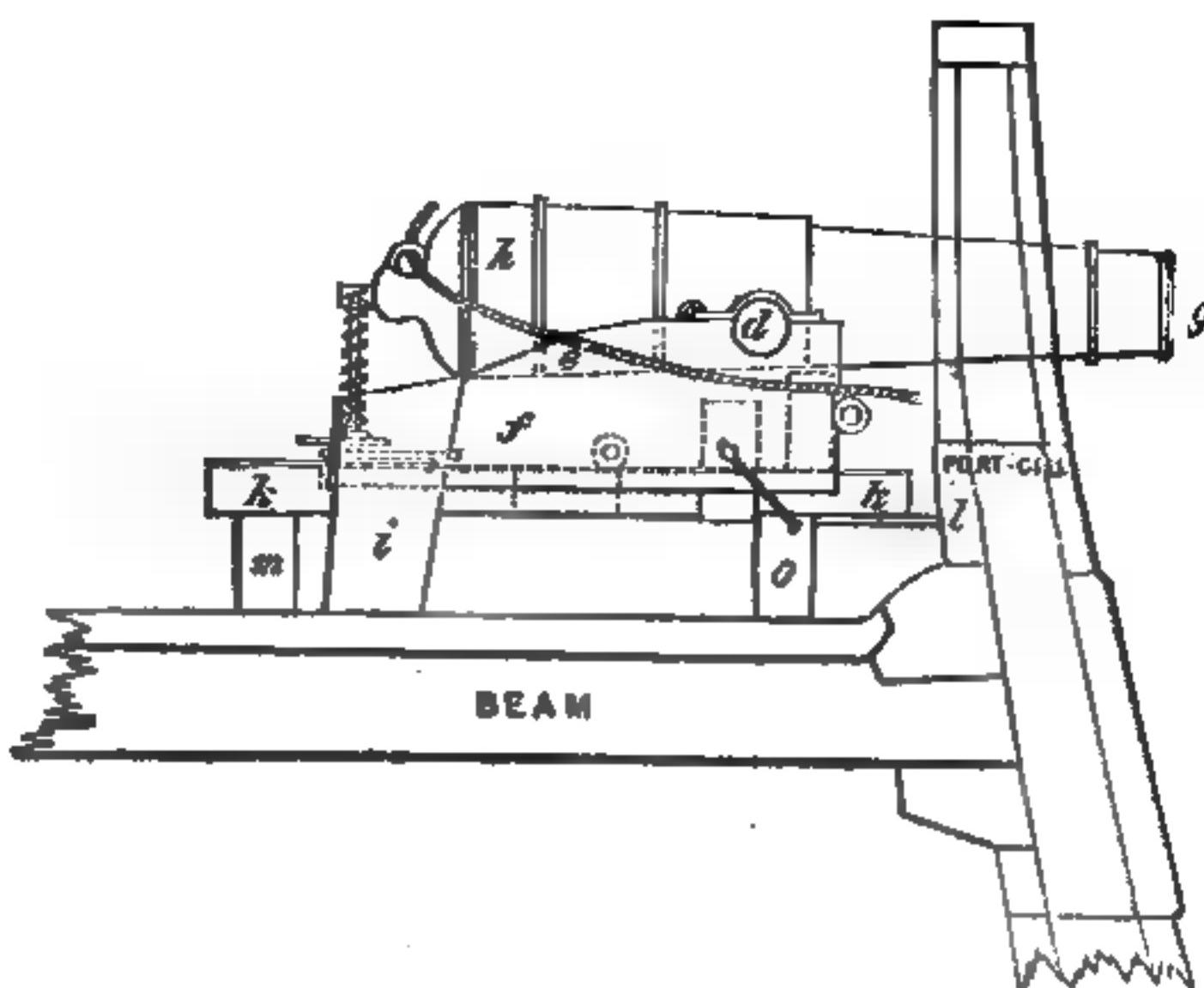
Shot supplied for each 32-pounder Gun of 56 cwt.

For the guns to which shells are supplied, 40 round shot to each gun.

For each of the other guns of the same calibre, 80 No.

Sloops armed with 24-pounders, 70 to each gun.

Fig. 3.—The front elevation of a quarter deck ■ forecastle port for the use of ■ short gun, called ■ caronade—the ■■■ given to them from this

Fig. 4.—Section of the Port and Carronade.

species of guns having been suggested at and cast by the iron foundry at Carron. Length of gun, 11 feet 11 inches; weight of gun, 25 cwt.; weight of carriage and slide, 5 cwt.; height of sill from deck, 1 foot 10 inches.

a, Train tackle eye bolts.

b b, Breeching bolts ■ described for the long guns.

c, Eye bolts for extreme training of the guns, $\frac{1}{2}$ inch in diameter.

**Fig. 4.—Elevation of the side of the ship and gun ■ the carriage. Weight of the carronade, 25 cwt.*

d, Trunnion of the carronade or axle of motion for depression ■ elevation.

e, Breeching or rope to restrain the recoil.

f, Carriage of the carronade designed by the late Sir Thos. Hardy, being ■ carriage for the gun, with an inner leg (*i*), travelling over ■ slide (*k*) which slide is pivoted to the plate (*l*), securely bolted to the side of the ship; the carriage (*f*) is so constructed ■ to admit of its being squeezed or compressed down ■ the slide (*k*), which produces a friction that takes off part of the recoil of the carronade from the breeching (*e*).

g, Muzzle of the carronade to receive the powder and shot.

m, Inner wood chock to slide (*k*), ■ keep it the required height ■ the deck,

n, Outer wood chock to slide, for the ■ purpose.

Rounds supplied of filled Cartridges for each Carronade of 25 cwt.

	Full. ■ No.	Reduced. 30 No. 2 lbs. 8 oz. 40
Charges of powder . . .	4 lbs. 0 ■	
No. in each powder ■		

TABLE OF THE POWDER ■■■■■ TO THE SEVERAL RATES OF
HER MAJESTY'S NAVY.

Rate of the Ship.	Number of Metal-Lined Cases.					
	Whole Cases,	Half Cases.	Quarter Cases.	Gross weight of Powder and Cases.	11 distant range in ■ case.	
Guns.				tons cwt.		
1st rate of 120	636	40	3	33 ■	16 full cartridges in ■ case.	
1st , , 100	617	43	3	32 0	20 reduced cartridges in ■ ■■■■ for 32. pounders.	
2nd , , 92	558	42	2	29 0	Guns of 56 cwt.	
2nd , , 80	475	38	■	25 0	Rounds supplied per gun of filled cart- ridges.	
3rd , , 72	361	33	■	19 0	Distant, Full, Reduced, No. No. No.	
4th , , 50	312	24	1	16 0	20 20 40	
5th , , 42	173	20	1	10 0		
5th , , 36	215	19	0	11 0		
6th , , 26	115	14	2	■ 0		
Sloop of 18	54	12	2	3 0	Charges of Powder } lbs. lbs. lbs.	
Brigantine 3	15	■	2	1 0	10 8 6	

PART XXVII.

Midship Section ■■■■■ linearly described in Plate 2.—References to the several Portions of it, ■■■■■ pointing out the relative Positions, by Sections, of the Timbers.—Planking, inside and out.—Beams and Decks.—Method employed if required to take off Ship when built.—References to Plate 4, as descriptive of the Methods which have been adopted in putting Beams together when they ■■■■■ composed of ■■■■■ than one piece.—References to a Sketch of the Deadwood of a large Frigate.—Method of making Floors in the rising Portion of the Ship's Frame.—Expansion of a common Frame of Timbers, and one composed of long and short-armed Floors.

THE delineated midship section of the draughtsman is a linear drawing, descriptive of the shape of the vessel both externally and internally, at the centre athwartship section of her; and on it is shown the view that would be presented to the eye of an observer, ■■■■■ a ship when built cut into two portions at the middle of her length. In the ship under such a division, the form of the timbers of the frame would be wholly and fully developed, or at least the moulded ■■■■■ shaped surfaces of them; but the sectional areas, or breadth and thickness, of each of the several stakes of plank, composing what are termed wales, diminishing plank, &c., would only be observable.

It is true, however, that these would each be seen ■ their relative heights from the keel of the vessel, and at their relative breadths from the middle ■ of her ; and thence on the draughtsman's paper will be found, ■ scale, a miniature picture of that portion of the vessel, and the relative heights and breadths of the several sections of the ship's wales, diminishing planks, &c., be depicted ■ it with great accuracy.

On this plate is also given the disposition, or shift of butts, or ends of the timbers composing the frames, in the midship part of the ship—being ■ longitudinal view of the internal arrangements amidships of the frame or ribs of her. This view is ■ projection of the form of the vessel as to height, but descriptive of the length of that portion of her to ■ scale of measurement. This will be better understood by tracing the $\frac{1}{2}$ floor head of the section marked ■ H, to the $\frac{1}{2}$ floor head of the disposition of the frame. In the section the whole length and form of surface of the $\frac{1}{2}$ floor is shown ; while, in the disposition, the same extent of timber is represented by the projected height of the floor head above the lower edge of the rabbet of the keel of the ship : the same will be correct for the relative positions in height of every other point in these pictures of part of a naval construction.

References to the Midship Section, Plate 2.

- A, The thickness of the several decks or platforms : vide Scheme of Scantlings.
- In small vessels the decks are named as follows :—Upper deck, lower deck, ■ platforms. In a ship carrying 74 guns, ■ ■ ■ of two decks, where the guns range fore and aft the vessel—poop, quarter-deck, waist and forecastle, main deck, lower deck, orlop, platforms.
- B, The beams placed across the ship to receive the platforms or decks.
- C, Waterways to receive the decks and secure down the ends of the beams (B).
- D, Shelf pieces ■ the several decks (A), to receive the ends of the beams (B), and form part of the security of the beams to the side of the ship.
- E, Iron knees, to further connect the beam (B) to the sides of the ship, and thereby to unite the two sides of her firmly together. These knees, under this view of the carpentry of a ship, may be considered as an increase in the breadth of the shelf (D), the required size of iron being much less cumbersome than the wood of equal strength would be ; the dotted lines through the side, and up and down to each of the knees E, are descriptive of the position of the bolts in the knees which form their security to the beam and side of the ship.
- F, Thick strakes of planks worked ■■■ the heads of the floor timbers and the heads of the 1st futtocks, to prevent the heads and heels of these timbers of the frame from being forced in. They are bolted ■ united to the

timbers and outside planking by the thorough fastening of the bottom plank.

g, Limber strakes, to form a gutter leading to the pump well on each side of the keelson (**H**), that the water from leakage may, by draining down to it, pass freely through it to the pumps, which are placed in the immediate vicinity of the main mast.

The limber boards are shown by this section with one end on the keelson (**H**) and the other on the limber strake (**G**) ; these boards form a covering to the limbers, to keep them from being choked with dirt. Sometimes the limbers are covered by iron castings forming part of the ballast required in the ship.

H, Keelson, or internal keel, to confine, in conjunction with the keel (**X**), the floors of the frame of the ship in their places ; the keelson bolts which pass through keelson, floor, and keel, — in a 1st-rate, or 120-gun ship, $1\frac{1}{2}$ inch in diameter.

I, Fillings between the timbers of the frame, being less than the moulding of the timbers by the distance the dotted line is below the full line of the section of the timbers, forming a watercourse to the limbers.

K, Section of the keel showing the rabbet for the reception of the plank of the bottom.

L, Section of the false keel used to give depth of immersion to the vessel, and which, by its being slightly secured to the main keel, admits of being easily removed by a blow should the ship strike the ground.

M, The rough tree rail forming the upper boundary of the timbers of the frame, as well as of the exterior and interior planking.

N, Wales or thickest planking used exteriorly.

O, Iron riders, shown in the disposition of the frame. The thickness and breadth of them used in the several rates of ships are given in the scheme of scantlings ; they — sometimes let into the timbers of the frame their whole thickness, at other times half the thickness ; and the system has been adopted by — practical builders of bringing them to the timbers without letting them in at all. The question hinges on this : Which is the best for the strength of the ship—to — into the timbers only ; to score — notch into the timbers and internal planking equally ; — to take the whole scoring out of the internal planking ?

P, The bearers of the boilers of a steam vessel placed on this section from want of space in this small work. They — worked the length of the engine-room and 10 feet beyond at each end ; they receive the boilers — large kettles and the engines, and form to the steam vessel the sister keelsons of sailing ships.

T, Of the disposition, shows the openings between the timbers of the frame marked by the shaded lines. These openings, — before remarked, should

be equalized all the way up the frame ■ the highest point at the rough tree rail (m) ; the dotted lines show the height of decks.

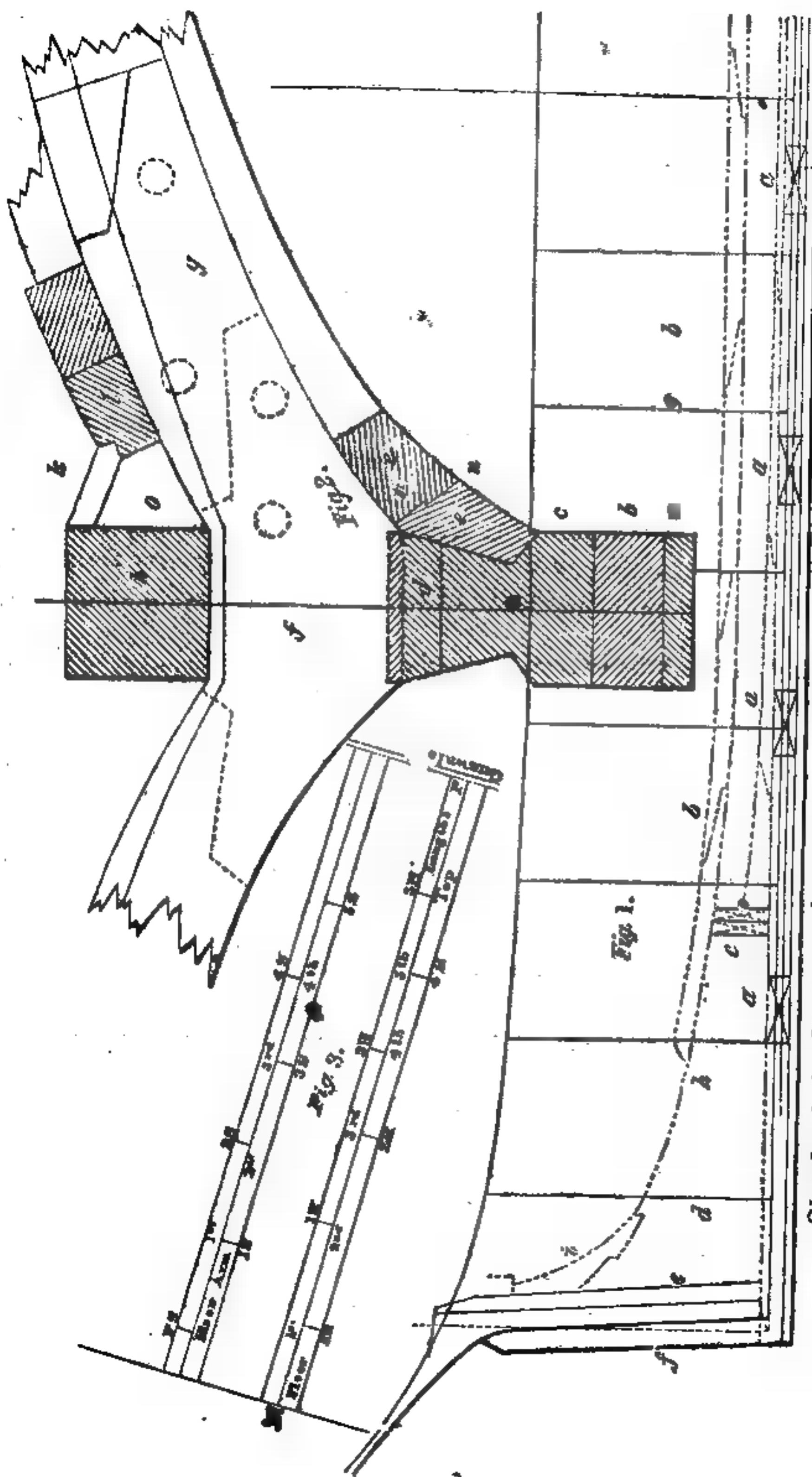
The sections of the thickness and breadth of each portion of the wales, diminishing plank, and plank of the bottom, ■ shown by the shading lines in the section.

A SHORT STATEMENT DESCRIPTIVE OF THE METHOD USED ■
TAKING THE FORM OF A SHIP, WHEN BUILT.

The circumstance of many ships during the last ■ being captured from the enemy, of whose form ■ draught ■ drawing ■ in the possession of the captors, and their good sailing qualities being such ■ to make them ■ desirable guide for English naval construction, it was the practice to have such vessels placed in ■ dry dock (Plate to Dock), and their forms taken off by a draughtsman, and ■ drawing upon the usual scale made of them. The outline of the method pursued is shown, attached to the midship section of Plate 2 ; and, ■ the process for one section would nearly carry the novice through the whole operation, the description of the one section being taken must suffice.

A base board (q), or board having the numeral feet marked on it, is placed against the side of the keel (k), this base board, q of the figure, being set by a spirit-level to the horizon, and square to the keel by ■ large square, placed with one of its arms against the side of the keel, and the base board q, being kept to the other. Another board (R q) is then fixed perpendicularly to this, as shown in the section, having also the graduated scale of feet marked ■ it. The distances at every 2 feet from these standards of measurement ■ then taken ■ the plumb ■ perpendicular, and the level ■ horizontal (as shown ■ the figure by the dotted lines) to where they meet the body of the ship or the wales, diminishing plank, bottom, &c. ; these distances ■ registered in feet and inches, and set off on paper to the scale chosen for the drawing, when the form of ■ the section cannot fail to be accurately depicted.

The perpendiculars, marked ■ in the section, form the boundary lines of the greatest transverse section or midship section, and thence inclose all other sections taken under the ■ system. It ■ ■ tedious operation, but it ■ thought necessary at one period to do it for every new vessel in Her Majesty's service, after being coppered, that her form might be the more accurately obtained for ascertaining her light displacement ■ weight of hull ; but surely the drawing by which the vessel ■ built could not, in the government service, be ■ much deviated from in building, as to make this operation necessary for detecting what would be, at the utmost, the immersion of one inch, and thence the custom has fallen into disuse, as ■ form of office to be more honoured in the breach than in the observance.



Sketch of the Shaft of Deadwood, and Section of a Floor on a larger scale.

REFERENCES TO PLATE 4 OF BEAMS.

The beams should, where practicable, be in ■ length, to avoid the expense of workmanship, and to insure strength. In large ships they cannot be obtained in one, and hence necessity suggested the arrangements described in the plate.

Fig. 1.—The beam ■ usually put together, when the store of timber will allow of its being provided in two pieces; it is then technically termed ■ two-piece beam. The dowels employed to connect the scarph ■ marked thus (o), the bolts (·); and of the two views shown of the beam, the upper ■ is ■ side one, or moulded, and the lower the sided, and shows the scarph ■ overlap of the two pieces, ■ ■ ■ the upper part of the beam; the scarph is usually $\frac{1}{3}$ rd the whole length of the beam.

Fig. 2.—In large ships, to obtain the beams, ■■■■■ is had to forming the beams of three pieces, of which fig. 2 is ■ descriptive drawing. The bolts and dowels are shown as described for fig. 1, and the scarph is usually $\frac{1}{4}$ th the length of the beam.

Fig. 3.—Descriptive of the moulded and sided views of a beam on the plan suggested by Mr. William Edye, Master Shipwright of Devonport Yard; it is a modification of the key scarph of the joiner of very ancient date. The iron keys, which are shown in the sided way by the square □, ■ tapered to form wedges. The lips of the scarphs, or the extreme ends of each overlapping part, are shown wrong in the figure; they should have been drawn square to the moulded edge of the beam. This beam is secured in its scarph by bolts marked (·), and the tree nails marked X. The scarphs of Mr. Edye's beams ■ in lengths from 8 feet to 11 feet .6 inches in the beams of ■ line-of-battle ship.

Fig. 4.—A modification of Mr. Edye's beam, having only ■ key to it. This method of scarphing was introduced by the Committee of References instituted by the Admiralty in 1846.

Fig. 5.—A beam suggested by Mr. Lang; it is bolted and coaked in a similar manner to that described for fig. 1: the lip being let in with a dovetail ▷ is the characteristic of this plan.

*References to the Sketch of a Shaft of Deadwood for the After Body
of ■ large Frigate.*

Fig. 1 Is ■ drawing made by the draughtsman, to show the relative positions of the masts of the ship, the scarphs of the keel, those of the keelson, and the distance to which the floors ■ lower timbers that cross the keel ■ extended (see description of Cant Bodies) from the midship part of the vessel each way.

- a, Scarphs of the keel; the number of the scarphs, or the lengths of the several pieces the keel is composed of, being determined by the store of timber.
- b, Scarphs of the keelson, which should [redacted] between those of the keel and have two bolts passing through them (vide description of the Keelson).
- c, After square floor, abaft which the lower timbers of the frame, or those called the double and lower futtocks of the cant body, take their heeling or abutment against the deadwood (d); [redacted] practical builders employ cant floors, but the difficulty which is found in obtaining the after square floors, will deter the economical shipwright from attempting a combination that yields but little probable advantage, [redacted] great and positive expense.
- d, Deadwood, to form the fine after-portion of the ship's body, and serve as a foundation to fix the heels of the after timbers of the frame against. It should never be converted from over-grown timber, which would be liable to early decay, from the difficulty in removing it for repair.
- e, Is descriptive of the overlap of the after piece of keelson (b) over the deadwood (d), by which means, when the keelson bolts [redacted] driven, which pass through keelson, deadwood, and keel, the after deadwood is connected thereby with the floors of the ship, and the joint at c, or where the deadwood [redacted] against the aft side of the floor (c), is succoured.
- f, Inner post of the ship into which the after ends of the deadwood (d) [redacted] tenoned.
- g, Main post of the ship.
- h, Stations of the sheer drawing of the ship, or the room and space for the timbers in her.
- i, Sternson, or a knee to connect the after end of the deadwood (d) with the inner (e) and main posts (f) of the ship, large bolts being driven through them in a fore and aft direction.

Fig. 2.—A section on [redacted] enlarged scale descriptive of the method adopted when the V like form of the ship foreward and aft [redacted] the floor timbers which cross the keel not easily to be obtained.

f, Shows the short chock crossing the keel with scarphs to receive the heels of the 1st futtocks, as depicted by the dotted lines of the fig.; the dowels are also delineated that connect the chock to the half floor of the frame. The loose tie which is shown by this method, but which necessity renders imperative when the floors [redacted] carried aft or forward beyond a certain limit, will illustrate what [redacted] adverted to in the description of fig. 1 of this woodcut.

- a, Lower false keel.
- b, Upper false keel.
- c, Main keel.
- d, Rising wood, to form the body and receive the scoring of the floor; the

- conversion of the floors is rendered easier if the throating of them is diminished by increasing the rising wood (*d*).
- e*, Thick garboard strakes rabbeted [redacted] each other to make the [redacted] for caulking (*m n*) the same as the thickness of the bottom plank.
- f*, Floor or chock.
- g*, Half floor butting at the middle line of the ship.
- h*, Keelson [redacted] inner keel of the ship, forming with the keel (*c*) the fore and aft connection of the floors (*f*).
- i*, Limber boards.
- j*, Limber strakes.
- o*, Limber [redacted] passage for the water to the pumps.

*Fig. 8.—An expansion of two consecutive frames of the ship, when the common system of floor and 1st futtocks meeting at the middle line of the ship is conjoined with [redacted] alternate frame composed of long and short arched timbers crossing the keel, [redacted] where on one side, the timber crosses the keel to the floor stirkmark marked *r s*, and the other end of the same timbers lengthens to the first stirkmark of the common frame marked *r s*, or the heads and heels of each alternate frame of the ship are by this arrangement brought in a line with the stirkmarks of the common shift of timber, which makes three timbers between each head and heel or joint, but [redacted] very short shift or scarph. The plan has been pointed out under the head of Framing the Ship.*

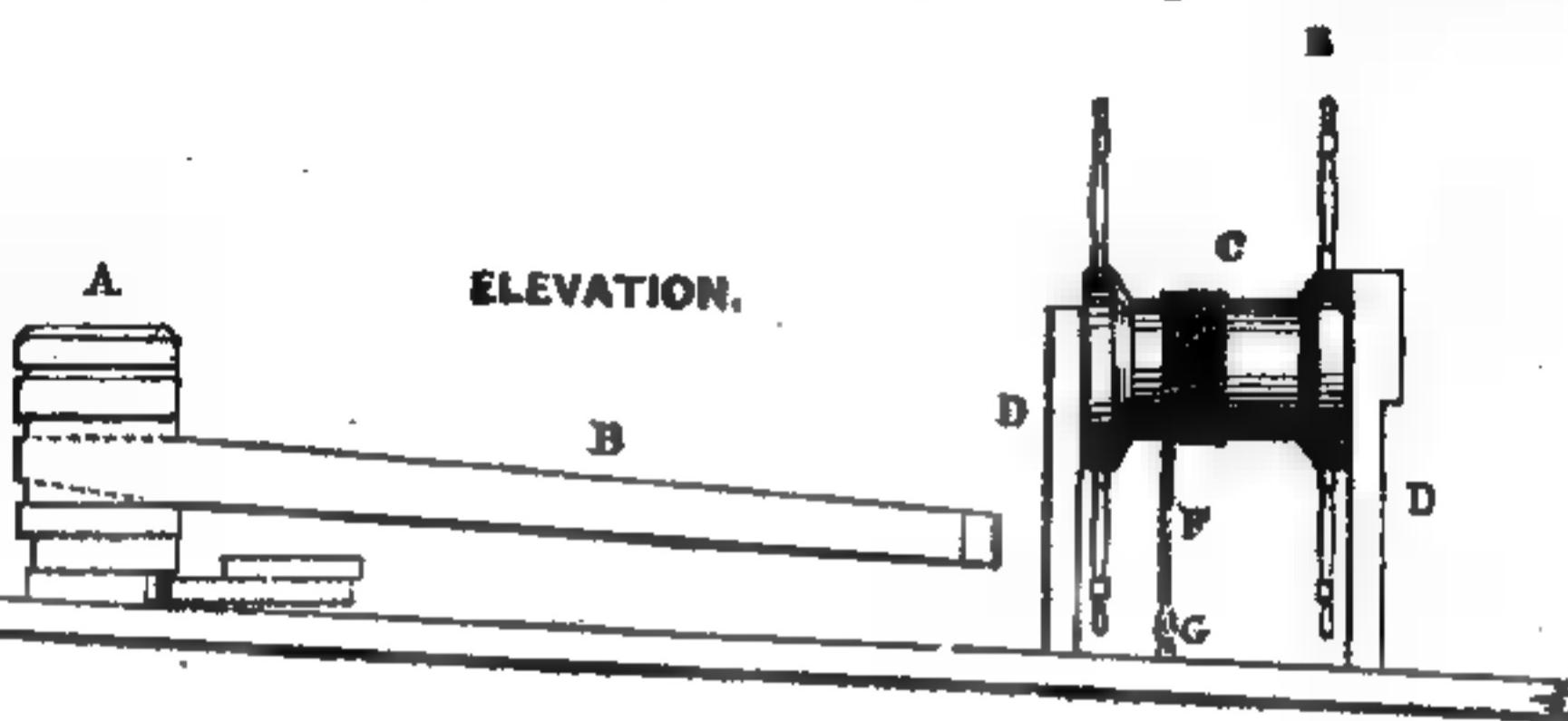
PART XXVIII.

Description of the Method employed to remove Slack Ropes in the Tiller of Her Majesty's Ship North Star.—References to the Elevation and Plan of the Sketch, describing the Method of reaving and fixing the Tiller Ropes.—Eye Bolts for relieving Tackles; where placed.

REFERENCES TO THE ELEVATION OF THE SKETCH.

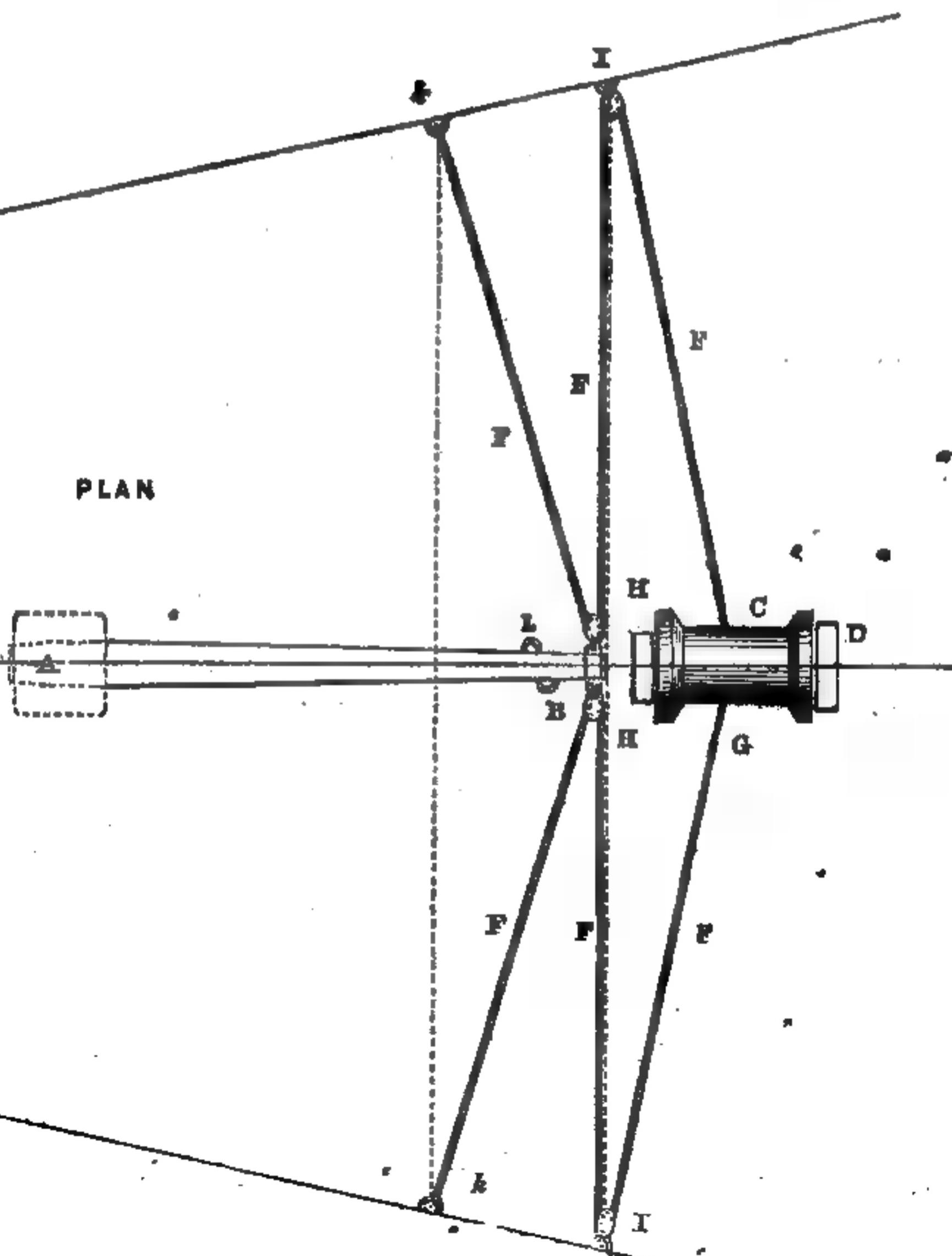
- A*, Section of the head of the rudder with the tiller inserted in it.
- B*, Tiller of wood. Formerly all tillars [redacted] made of wood, and they were of greater length than now.
- c*, Steering wheel, composed of a barrel and spokes inserted into the ends of it, the outer ends of such spokes forming handles for the [redacted] stationed at the helm to take hold of in steering the ship.
- D*, Wheel stanchions or supporters of the axles on which the wheel (*c*) travels.
- E*, Extreme end of the spoke of the wheel (*c*), being the place where the helmsman places his hands to steer.

Sketch of the Steering Wheel of Her Majesty's Ship, North Star.



ELEVATION.

PLAN



r, Tiller ropes wound round the barrel of the steering wheel (**c**). The wheel thence becomes the mechanical power denominated the wheel and axle, the spokes of it being the wheel of that power, and the barrel of it the axle.

The diameter of the barrel of the steering wheel is determined by the length of tiller rope which is required to be taken up in forcing the tiller over to the greatest angle, or in nautical terms putting the helm hard down, which angle for efficiency is considered in the Queen's service to be that of 42 degrees, from the fore and aft line of the vessel, out of the quadrant or 90 degrees. This is required on each side of the midship position of the tiller, and thence the quantity of tiller rope on the barrel of the steering wheel, when the helm ~~is~~ tiller is amidships, must be double that quantity, as half of it has to be unwound from it at either end, and added at the other according ~~as~~ the helm is put starboard or port, to the right hand ~~as~~ the left, so that the same number of turns of tiller rope are always on the barrel of the wheel; and when the helm is hard down either way, the whole number of turns are before or abaft the centre of the rope wound on the barrel in the midship position of the tiller. The number of turns of rope on the barrel of the steering wheels of the ships of the navy is five ~~as~~ seven; the odd number being requisite, that the centre of the tiller rope wound on the barrel of the wheel, when the helm is amidships, may be on the upper surface of the barrel, to which it is firmly secured, to prevent the tiller rope slipping round it.

s, Position of a block in the deck of the vessel, confining the tiller rope (**r**) on each side of the barrel of the steering wheel.

REVERENCES TO THE PLAN OF THE SKETCH.

A, Rudder head.

A B, Length of tiller.

c, Barrel of steering wheel.

d d, Sections of the stantions of the wheel of elevation.

e, Position of blocks in the deck, to confine the tiller rope (**r**) to the diameter of the barrel of the steering wheel.

f, Tiller ropes wound round the barrel of the wheel as shown ~~as~~ the elevation. The ends, after being ~~as~~ wound, are led first through the block (**g**); from thence through the block (**i**) at the side to a block (**h**) ~~as~~ either side of the end of the tiller (**A B**); from whence the end is led to the eye bolt (**k**), where it is drawn taut in and secured. The positions of the eye bolt (**k**) and block (**i**) to prevent slack rope, ~~are~~ determined on each side by the following process:—the tiller (**A B** of the plan) ~~is~~ put through an angle of 42 degrees each side of the fore and aft position shown on the sketch, and the portion of the circle thence

described by the end (B) of the tillar — marked on the deck ; the tillar — then restored to the fore and aft position as in the sketch, and $\frac{1}{3}$ rd of the length of it, — denoted by the dotted line, was set off from the fore end of the tillar, and squared — the ship, giving the points marked *k* in the plan for the standing part or end of the tillar ropes, and $\frac{1}{2}$ th of A B — set before the end (B) of the tillar, and squared — the deck to meet the sides of the ship in the opposite points (i), to which blocks were fixed ; and — the tillar rope being rove through these, in the manner before described, it — found that the tillar rope (F) was at equal stretch in every position of the tillar. When great accuracy is required, the points *k* and i should be relatively placed — that i in athwartship breadth may exceed *k* by $\frac{1}{4}$ th of *k*; or that the distance ii is $\frac{1}{2}$ th times that of *k*.

- L, Eye bolts placed on the tillar to receive the hooks of purchases — tackles called relieving tackles, by which the vessel is steered in the event of a casualty occurring to the tillar.

The tillar ropes of the navy — made of twisted hide.

PART XXIX.

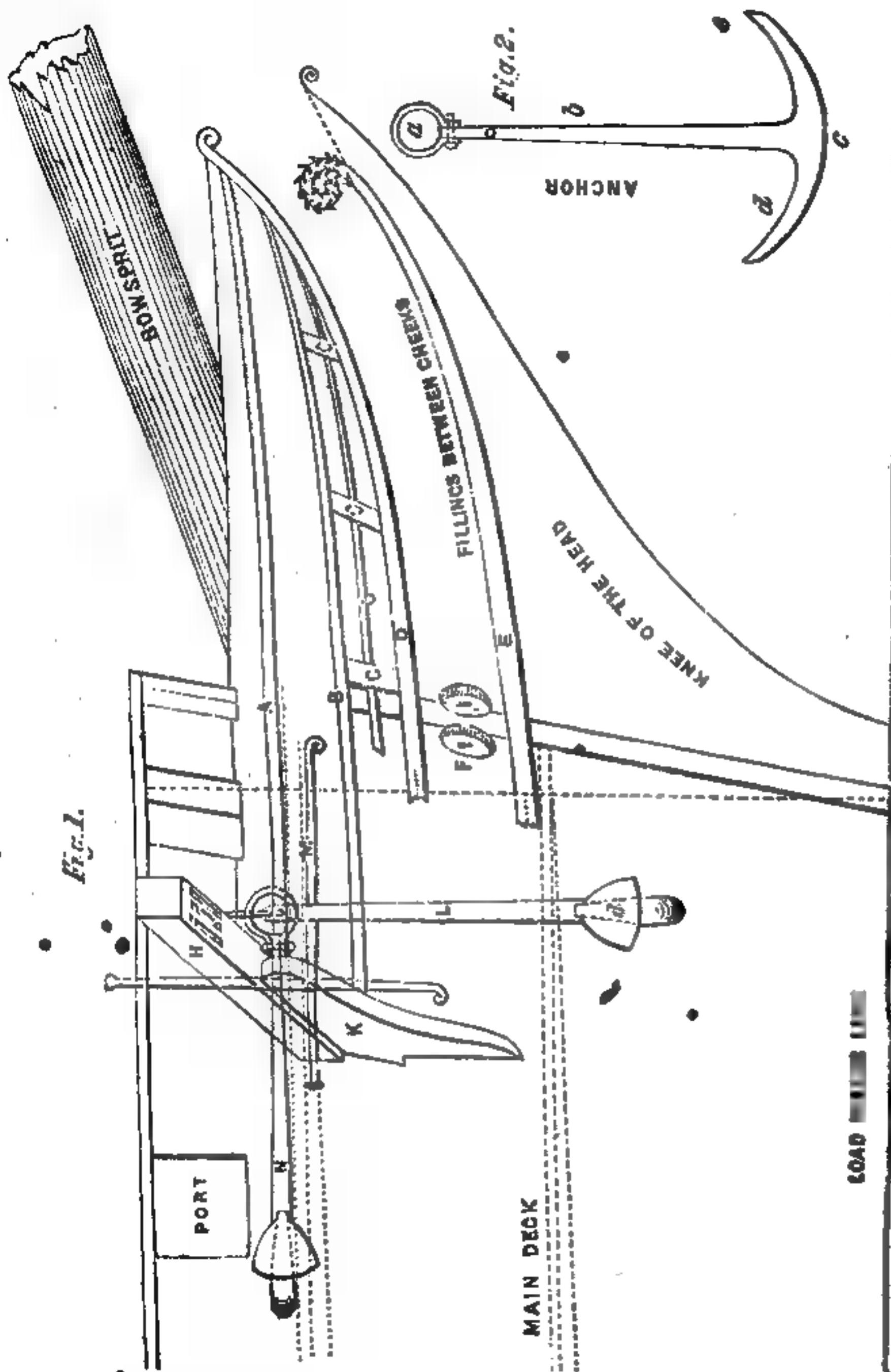
References to the Sketches of the Head and Stern of a Frigate.—Outline of the Terms used to distinguish the several Portions of them.

THE sketch is descriptive of the component parts, or of the external fittings which form the head of a frigate. They are considered essential to the ship, either — forming a portion of the required arrangements for the efficiency of the movements of her, or to be necessary to complete the outward appearance of the ship. The finish given to the extremities of the ship, — to the head and stern (being — appeal to the taste and judgment of the observer through the medium of the eye), the naval architect should, in a great degree, regulate by that organ, as the best means of producing the desired effect—that of giving a light and graceful appearance to that part of the hull of the ship which is above the seat of water or line of immersion at which the vessel swims.

REFERENCES TO THE SKETCH — THE HEAD.

Fig. 1.

- A, Berthing rail, forming the safety or guard to the men when they are out in the head, the flat or platform of which is — a level with the main rail (B).
- B, Main rail, to fashion out the head, and to afford an inclosed space for accommodation — the crew.
- c, Middle — small rail, introduced for the exterior appearance of the ship.

Sketch of the Head of a Frigate

d, The after part of this fitting, with a portion of it 6 or 8 feet on the knee of the head, is called the upper cheek, and forms, by being bolted to the bows of the ship and to the knee of the head, a species of wooden knee to support

the latter. The after arm of this knee is shown in projection in the figure or picture of the bow of the ship; but ■ the knee of the head it describes the form and length of it. The moulding or breadth is usually at the throat of it, $2\frac{1}{2}$ times the depth of the cheek. The fore part of D is called ■ "eking," the extreme end of it, shown by ■ scroll on the figure, being termed ■ "hair bracket;" and this hair-bracket should, for symmetry of appearance, be placed rather below the shoulder of the figure-head.

E, Lower cheek, a wooden knee, as described for the upper cheek, and bolted also to the bows of the ship and knee of the head. The bolts in the knee of the head ■ of these cheeks pass through similar knees on the reverse side of the knee of the head.

F, Bolsters of wood placed between the ■ of the cheeks (D and E) that ■ against the bows of the ship. These bolsters ■ worked to form beds for the iron hawse pipes (I), which ■ put through the sides of the ship to form holes for the cables to run out of. The bolsters should slightly project over the moulding way or breadth of the cheeks, to form ■ protection to them. They are bolted to the side of the ship independently of the bolts which secure the hawse pipes (I). Immediately forward of the bolsters, ■ piece of wood termed a corner chock is usually worked, the intention of it being that the fore ends of the planks, called wood ends, may, by the removal of it, be caulked without disturbing ■ taking out the hawse pipes, or taking down the bolsters, an operation attended with expense and loss of time.

The fillings between the cheeks on the knee of the head are of fir, and are intended solely for the better appearance of the ship, under which view of their utility they have been in many instances dispensed with.

G, Timbers of the head, to support the middle and main rails. For a light and airy appearance, the after one is placed ■ the rake ■ inclination of the stem; the next with $1\frac{1}{2}$ inches more rake; and the foremost ■ with $1\frac{1}{2}$ inches more rake than that, or with 3 inches more rake to it than the one at the stem.

There is a thin birthing of board placed between A and B; and over A what ■ termed a wash board is sometimes used, while this is much oftener supplied by ■ iron rod, termed an iron horse, to which painted canvas is affixed.

H, Cathead, to raise the anchor from the water's edge.

I, Supporter or knee to H, bolted firmly to the side of the ship and to the cathead. The use of it is expressed by the ■ given to it, that of ■ support to the cathead.

L, Anchor hanging to the cathead, or what the sailors termed cock-billed.

M, Anchor stowed on the bill board.

Angular pieces of fir, called wash boards, ■ placed under the lower cheeks and ekings.

Fig. 2 (Anchor in parts).

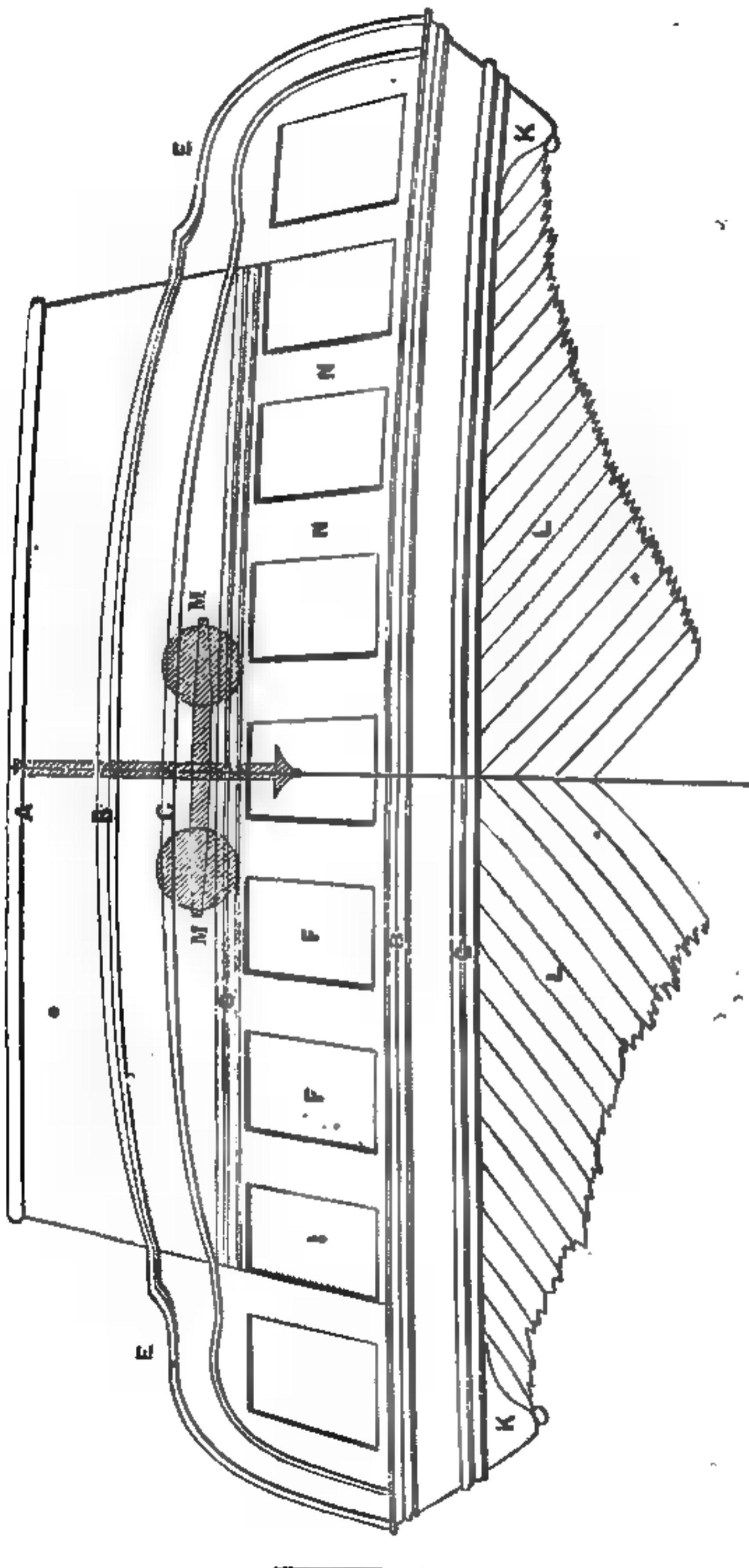
- a, Shackle to which the cable is united.
 - b, Shank of the anchor.
 - c, Crown of the anchor.
 - d, Palm of the anchor.
 - e, Pea of the anchor.
-

SKETCH OF ■■■ STERN OF A FRIGATE.

The taste of the practical man will be tested in the fittings of the stern of the ship, in the same ratio as for those employed for the embellishment of the head of her, with this additional difficulty to overcome in the former—that of having to please the eye under the changes in point of view, which take place while the sight is carrying round ■■■■■ from the sloping or raking surface presented by the right aft stern, to the perpendicular plane forming the fore and aft plane or topsides of the ship.

REFERENCES TO ■■■ FIGURE, p. 168.

- A, Taffrail.
 - B, Boundary rail, or moulding to form part of the decoration to the stern.
 - C, Cove rail.
 - D, Heading to lights or windows, marked E.
 - E, Windows framed in the houses on shore, having cills to them termed water tables. They are hung in sashes, upper and lower, with weights, and the shutters fitted to them are called dead-lights, a name that has conjured up the fears of many a landsman.
 - F, Upper counter rail. } These are brought against the timbers of the
 - G, Lower counter rail. } frame, and form plank and projecting moulding.
 - H, Quarter pieces, allowing accommodation to the captain outside the ship.
 - I, Lower finishing, wholly for appearance.
 - J, The plank of the bottom, or buttock plank, housed under the lower counter rail (G). This plank should be worked without the use of an edge to prevent its being crippled.
 - K, Life buoy, fitted over the stern.
 - L, Munion, to fashion out the window and inclose the grooves for the sash-weights.
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Sketch of the Stern of a Frigate.

PART XXX.

A short Description of the Process used to make the Seams of the Planks of a Vessel impervious to Water.—Terms of ■■■ of the Tools used for that purpose.—Scale of the Width of Seams according to Thickness.—Seams of Decks sometimes payed with Jeffery's Marine Glue.—Copper Sheathing employed on the immersed Portions of the Ships of the Navy formerly payed with Pitch and Tar.—Weight of Copper Sheathing to each superficial Foot.—Concluding Remarks.

THE joints of the external planking, or what are mechanically termed the seams of the planks, require to be made impervious to the water, that the ship may swim, which is effected by forcing into them, by means of sharp iron wedges called caulking irons, spun threads or layers of oakum, formed by taking to pieces, in the Queen's service, the unserviceable ropes and cables, after such have been cut up into short lengths, termed "junk." The seams of the planking, when they are under the standard width for the several thicknesses of it, are opened to that required, by sharp and large iron wedges called reeming irons being driven into them by a heavy mallet, which in the trade is styled a beetle; and in this operation the skill of the caulk is drawn out, and the work of the shipwright tried. The opening of the seams by such a powerful set or mechanical force, ■■■ that formed by a range of wedges of such acute or small angles being acted upon by the impetus given to them, from the smart and forcible blow of the heavy mallet or beetle, must close the seams above and below the one that is wished to be increased, and thence bring a strain on the fastenings of both planks: the caulk should therefore be careful to first caulk those seams which are under the standard width, and which are situated above or below seams that may be over the same width; and the shipwright should be in attendance, that, should the planking be forced off from the bottom by the operation of reeming—which it will be, especially where the seams or joints do not stand square to the timbers—he may put in

with. The stipulated number of threads of oakum having been forced into the seams by the mallet and iron of the caulkers, the whole is the more firmly bedded and united, and buried within the edges of the planks by the work being what the trade call "horsed up," an operation that requires two caulkers, the one holding by means of a handle the meeking or making iron to the seam which has been caulked, while the other drives on it with the full swing or blow of the beetle. After this process, melted pitch is payed by the means of small mops over the thus forced-up oakum; and finally, as high up the bottom of the ship as the copper sheathing will come, a thread of spun yarn is laid in to make the seam flush or level with the planking, that the copper sheathing hereafter to be described may be laid smoother on it. The bottom of the vessel is also payed up or covered over by the caulkers as high as where the copper sheathing is placed, with a mixture of pitch and tar. The decks of a ship are caulked in a similar manner with oakum; but the weather decks are payed with Jeffery's marino glue instead of pitch.

Scale of the Width of Seam according to the Thickness of Wales, Bottom Plank, and Decks, with the Standard Number of Threads of Oakum to be placed in each.

A scale for the width of the seam, according to the thickness of the plank, is formed practically by opening a 2-foot rule to the angle produced by $\frac{2}{3}$ ths of an inch at the extreme inner edges of the 12-inch arms of it.

Number of Threads of Oakum to be worked into the Seams of the Wales, Diminishing Plank and Bottom.

Thickness.	No. of threads.						
2 inches	2
3 "	4
4 "	5
5 "	6
6 "	7
7 "	9
8 "	10
9 "	11
10 "	13

Decks.

Thickness.	No. of threads.
2 inches	2 small.
3 "	2 "
4 "	3 "
5 "	4 "

The caulking always tends to stiffen the fabric of a ship, and it has thence been sometimes the practice not to caulk the internal planking until the ship has had several years' service at sea, when the caulking of it has been supposed to be the means of adding strength to the racked or strained fastenings of her.

COPPER SHEATHING ON THE BOTTOM OF SHIPS.

Up to the latter end of the last century it was the practice, in the navy of this country, that the immersed portions of the ships should be, as most of the ships of the mercantile navy are to this day, alone covered with a thick coating of pitch and tar. The quick growth of marine vegetable matter on the bottoms of Her Majesty's ships, which impeded their way through the water, when thus protected but partially from the destructive ravages of the sea-worm, added to the expense and delay which arose from the necessity of frequently having to dock the ships to bream them, or place lighted reeds under the bottoms of them, when in dock, to remove such vegetation; and that when on foreign stations, where this practice could not be followed up, and the sailing of the vessels was, from the foulness of the external planking under water, in some measure lost, led to the introduction of a thin coating of copper, called copper sheathing, being placed over the whole intended immersed portion of the bottom; and to the extent of 18 inches above that line of immersion. This coating is formed of sheets of copper in lengths of 4 feet and 14 inches breadth, the lower edges of the upper sheets lapping over the upper edges of those below them, and the after end of each sheet lapping over the fore end of the one immediately following it: the

thicknesses of the several descriptions of copper sheathing used in Her Majesty's navy are such as to make each superficial foot in extent of the several respective weights of 32 oz., 28 oz., 18 oz., and 16 oz., and under these denominations they are known in the trade. The 32 oz. copper sheathing, which is the thickest, is used all round the ship at the height of the load-water line for four strakes or sheets down, and on the fore part of her, on the bows down to the keel. The practice is to have, of the whole number of sheets of copper sheathing required to cover the surface of the bottom of the ship, $\frac{1}{3}$ rd of 32 oz. and the remaining $\frac{2}{3}$ rds of 28 oz., expending the residue of the 32 oz. copper sheathing, after working four strakes all round her, on the bows of the ship. The 18 and 16 oz. sheathing copper is usually placed between the main and false keels, to protect the former from the worm should the latter be forced off.

A species of metal, or a combination of metals, denominated Muntz's metal, has been of late generally used in the mercantile navy, and has been partially employed in the British navy, as being inexpensive when compared with copper sheathing.

No. of Sheets, &c., from a 120-Gun Ship to a 10-Gun Brdg.

Guns.	Sheets, of 4 ft. by 14 in.							
120	4444
84	:	:	:	:	:	:	:	3400
60	:	:	:	:	:	:	:	2250
46	:	:	:	:	:	:	:	1870
28	:	:	:	:	:	:	:	1240
10	:	:	:	:	:	:	:	633

The combination of the several parts, and the arrangement of the respective portions, of the vast structure which constitutes the man-of-war or ship for national defence having been detailed, it becomes necessary, under the prescribed limits of a rudimentary treatise, to bring to a close the brief remarks that have been made on that important subject—the practical carpentry of ships, as forming either the National Bulwarks of this country, or those on which, considered

as a nation of merchants, the Commerce, and thence the riches, of England depend—the mercantile navy of England. In the practice of ship building a wide field is opened for discussion, as the several systems that have from time to time been adopted admit freely of controversy.

In many instances the same end is to be obtained by either of two methods, and thence advocating their relative or respective merits could be productive of no positive good. Under such impressions, the plans proposed for the same purpose have, in this small work, been only described, leaving those who read such descriptions to draw their own conclusions as to their advantages or disadvantages in practice. With the hope that the practical hints which may here be found, and which have been compiled during the leisure hours of a professional course of duties, may be considered useful to the novice in ship building, as forming the lower step of a ladder towards his attaining a knowledge of practical ship building, when followed by him as a trade, and also be acceptable to the general reader, as a source of amusement and recreation from more abstruse reading, this Rudimentary Treatise on Practical Ship Building is brought to a conclusion; but still with a hope that it will be shortly followed by a Rudimentary Treatise on Masting, Mast-Making, and Rigging of Ships.

